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J. W. Ellis

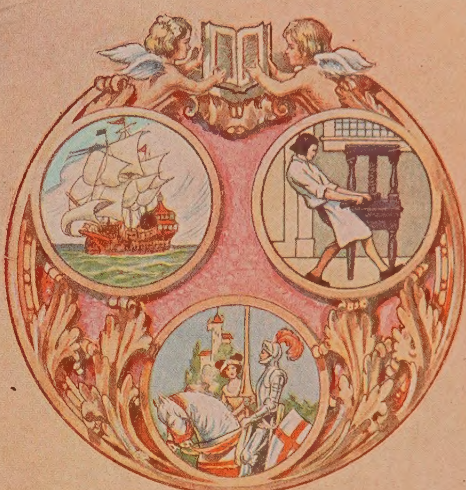
OUR WONDER WORLD
A LIBRARY OF KNOWLEDGE

In Eleven Volumes

OFF FOR THE PLANETS

OUR WONDER WORLD

A Library of Knowledge



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FOREWORD

A CERTAIN man had a boy who was an Animated Interrogation Point — one of the kind that can shoot Who? Why? What? When? and Where? at you faster than a rapid-fire gun. This irrepressible inquirer made things so uncomfortable at meal-time that at last the father agreed to pay him twenty-five cents for every week in which he did not ask a single question at the breakfast table.

Did you ever feel like doing that? If so, you and the boy both deserve sympathy. He ought to ask questions, because he wants to know things; and you want him to know them, even if you do not know them yourself —which often happens, and perhaps causes the trouble. At the same time, you ought to have a chance at your morning paper; the wife and mother ought to be as free from question target-practice as you are; and yet the questions must not be suppressed, because that means death to intelligence and to brain growth. Here is where this LIBRARY OF KNOWLEDGE comes to your aid and that of the entire household. It asks a multitude of questions and answers them — exactly the questions your boy and girl will ask, besides a host of puzzling ones for which you have found no answer.

Would you know about the heavens above, the waters beneath, or the earth between? about exploration or invention, adventure or achievement, people or places, captains of war or captains of industry, art or athletics, history or handicraft, canals or cooking, sport or story, —any and every sort of curious and fascinating thing? Fact, Fancy, and Fiction invite on every side in this OUR WONDER WORLD. Here are the keys to every door.

This LIBRARY is for entertainment. It is a pleasure path to knowledge. Its first aim is to be readable, because it wishes to be read. It is made on the principle that everybody is interested in everything that is interesting, and that nearly everything can be made interesting if rightly presented. It knows that what is written in a manner to attract the young will not fail to hold all classes and ages of readers; and it is confident that parents and teachers will appreciate the high standard of taste, accuracy, and beauty which it sets and which distinguishes it among all works of its class.

But while entertaining, this LIBRARY OF KNOWLEDGE has a very practical purpose also. It not only opens the eyes to the meaning and beauty of the world and its life, but also tells how to get the most and best out of life; how to treat the body well; how to play the best games and engage in healthful sports and recreations and occupations, indoors and out; how to use fresh air and fresh water; how

to enjoy the woods and fields by knowing the birds, trees, and flowers; how to get health and pleasure out of a garden by planting and tending it; how to make all sorts of useful things, thus training hand and eye; how to appreciate good books and pictures; how to discover the life work for which one is best fitted,—in a word, how to find joy in work and study as well as in play.

The Mother will find the Ninth Volume of rare value and suggestiveness, smoothing many a rough place and solving many a home perplexity. It is the outgrowth of experience, and its contents have met the test of home use. There is no other single volume like it. Here are described, for the Mother's aid, scores of simple home amusements and occupations that will keep the little child busy through long, happy hours. And here are collected delightful poems, tales, and nursery jingles, some new, some classic, with which the growing imagination may be enriched and enlarged, and the growing mind supplied with pleasant memories that will last a lifetime. These are the childhood treasures that will never be out of date.

This Library of Knowledge cannot fail to create a desire to know. It seeks to cultivate a taste for the best in literature, art, nature, and life, and to inspire the noble ideals of character that make life worth living. It should be an invaluable aid in the home, and in linking home and school in closer alliance. The teacher will find it a rich storehouse of fact and suggestion; the children will delight in its pictures and tales; the boys will start in with inventions and handicraft, and go on to the end; the girls will find that they have not been left out in their special interests; the parents will be led into new fields of unexpected interest; and the reader at large will unite with all in understanding better the most surprising and significant facts of Our Wonder World.

Howard B. Grose.

GENERAL ACKNOWLEDGMENT

IN the preparation of OUR WONDER WORLD the publishers have incurred numerous obligations to other houses both in the United States and abroad, for the use of material in the way of text and illustrations. Special acknowledgment of permission to use matter from works issued by other publishing firms is made at the beginning of each volume. We here desire to give cordial expression of our appreciation of the courteous treatment which we have received from all to whom we have applied. In the case of every book from which extracts have been made, we are glad to give our unqualified approval of such works and recommend their purchase to readers who wish to add to their libraries the best in literature.

In Volume I we acknowledge, with thanks, the courtesy of the following publishers in allowing us to use text and illustrations on the pages named:

D. APPLETON & CO., New York, for illustrations from "The Living Races of Mankind," by H. N. Hutchinson, J. W. Gregory, and R. Lydekker, on pages 306, 320, 339, 345, 346, 347, 349; and illustration on page 84.

CASSELL & CO., LTD., New York and London, for illustrations on pages 3, 7, 31, 33, 35, 37, 43, and 52, and also for selections on pages 42, 43, 44, and 45, from "Astronomy for All" by Bruno Bürgel, translated by Stella Bloch, an excellent and richly illustrated popular astronomy which those who desire to pursue the subject further will do well to read.

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GINN & CO., Boston, for the following illustrations from Frye's "Home Geography": "Rocks that Store Water," page 84; relief maps, page 185; "A Sponge from the Sea Bottom," page 220; "Coral," page 228; "An Odd Fish from the Deep Sea," page 245; from Gayley's "Classic Myths in Literature and Art," "Sunrise," page 107, "Prometheus Making Man," page 263, "Jupiter Surveying the World," page 272; and from Stickney's "Earth and Sky II," illustration and paragraph of text, page 64.

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Seeley, Service & Co., Ltd., London, for illustrations from "The Romance of Modern Astronomy," on pages 29 and 103; from "The Romance of the Animal World," on page 147; from "The Romance of Savage Life," on pages 281 and 321; from "The Romance of Modern Geology," on pages 63 and 280; from "Scientific Ideas of To-day," on page 98; and from "The Childhood of Man," on pages 303, 304, and 310. This series is an interesting one which our readers will do well to look up. It is published in America by J. B. Lippincott & Co., Philadelphia.

Charles Scribner's Sons, New York, for illustrations from Redway's "Elementary Physical Geography," on pages 27, 65, 67, 71, and 104.

Frederick A. Stokes Company, New York, for the beautiful illustrations from "The Seashore," by F. Martin Duncan, remade and reproduced on pages 209, 211, 215, 219, 221, 222, 223, 224, 226, 227, 229, 230, 231, 233, 235, 240, 241, and 250.

"The History of Mankind" (3 volumes), published by The Macmillan Company, New York, has been the source for many of the pictures from page 275 on, notably the color pages facing 309, 351, and 355, and other smaller cuts in this and other volumes made up from illustrations taken from this valuable work. The Macmillan Company are also agents in this country for Adam & Charles Black, London, to whom we are indebted for the picture facing page 21, and illustrations on pages 23, 32, 35, and 49, as well as for text in "The Open Book of the Heavens," from their two excellent popular books, "Peeps at the Heavens," by Rev. James Baikie, and "The Children's Book of Stars," by G. E. Mitton, both of which we are glad to recommend.

We wish also to mention the courtesy of the Canadian Pacific Railway Company in supplying photographs (pages 148, 149, 389), and of E. S. Jones, photographer, of Boston, and H. G. Peabody, also of Boston, for similar courtesies. The headpiece on page 364 is remade from a large color print of New York City, copyrighted in the original by I. Underhill, 1901.

We are indebted to the "Illustrated London News" for many science pictures, particularly in the astronomy section; and to "Harmsworth's Popular Science" for several illustrations from their valuable collection.

VOLUME ONE

THE WORLD AND ITS PEOPLES

Let knowledge grow from more to more,
But more of reverance in us dwell.

TENNYSON

CONTENTS

VOLUME I

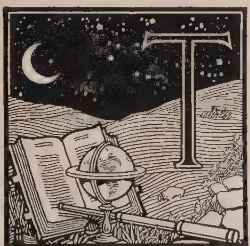
FULL-PAGE ILLUSTRATIONS

In addition there are 261 illustrations in the text, of which those with titles are catalogued under their respective subjects in the General Index in Volume X.

GALILEO OBSERVING THE HEAVENS

THE OPEN BOOK OF THE HEAVENS

HOW PEOPLE READ IT OF OLD, AND HOW THEY READ IT NOW

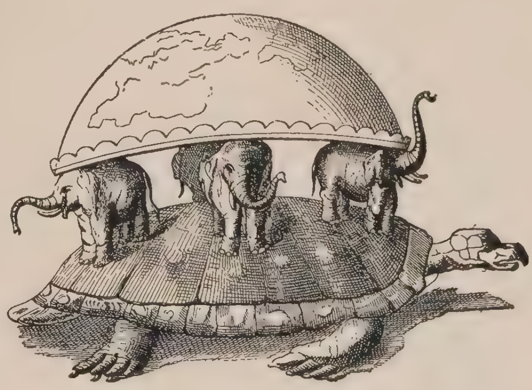


THE heavens are an open book in which the stars are the golden letters. All one need do is to go out after dark and look up, to see what a wonderful and fascinating book it is, and to wish to read at least a little way in it. Here are the stories of how the worlds were made and set on their endless travels along the sky tracks; of our earth and its place among the countless balls that go swinging through space; of the sun that heats and lights our world and keeps it from running off its track; and of all the strange things that puzzle us. No fairy book is half so good as this, which in truth has many fairy stories in it, as you will see.

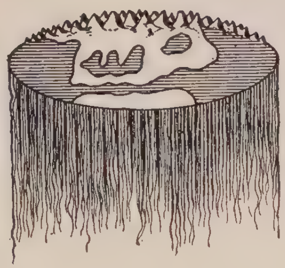
For in the olden days, when the world was young, men did not know so much about the heavens, and so they imagined more. They talked about the sun and moon and stars as if these were alive. They feared them and often worshiped them as gods. They saw that every night light was swallowed up by darkness, but in the morning light came again; and they pictured this daily change as a great world-war in which the demons of darkness and evil were fighting against the gods of light and goodness. Every day, every month, every year, this battle was fought, and the people prayed and sang at sunset and sunrise, hoping that darkness might not conquer forever, but that dawn might come again and light triumph once more over darkness, good over evil, as it always had.

WHEN PEOPLE THOUGHT THE EARTH WAS FLAT

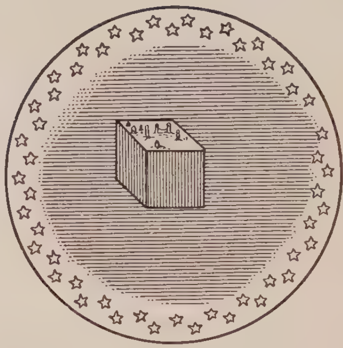
All the ancient peoples thought the earth was flat, or, if not perfectly flat, a great slightly curving surface. But if the earth was flat, what held it up, what did it rest on? On the backs of four elephants, said the Hindus. And what did the elephants stand on? On the back of a great turtle. Why a turtle? Because in the ancient animal beliefs the turtle stands always for strength, endurance, and length of days; and it would take a very strong and steady animal to hold up the world. But why the four elephants on his back? Elephants were strong, too. They could carry a very heavy load on their broad backs; and there must be four, so that they might stand at the four points of the compass — North, South, East, and West. You see, they had an idea, though you may think it a foolish one.



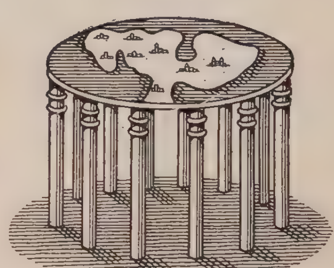
THE TURTLE THAT SUPPORTS THE WORLD



FLAT EARTH WITH ROOTS



PLATO'S EARTH CUBE



FLAT EARTH RESTING ON COLUMNS

The Chinese thought the earth was a great flat disc or plate, with China right in the center of it. Off from China there stretched other lands, and these lands reached out in every direction until they came to a great mysterious, marvelous ocean, which no man could ever reach. This flowed round the whole earth, and here dwelt pygmies and giants and all manner of strange monsters. People in other lands thought the earth floated on a great ocean, just as a lily pad floats on the surface of a pond, and that to keep it in place long, long roots reached down, nobody knew how far, into the water.

But if the earth was flat, what about the sky? The sky, they said, must be a big hollow half-globe, like the inside of a ball. Take a big bowl and hold it bottom side up above your head, and you will see their idea. The sky, of course, must be held up somehow, for it did not seem to rest on the earth. So they thought there were columns round the earth which held it up. And what did the columns rest on? Nobody knew, so there they stopped their guessing.

WHERE DID THE SUN GO AT NIGHT?

There was another question. The sun rose in the east every morning, and set in the west every evening. Then how did it get back to the east to rise again the next morning? It could not go through the earth. Did it go under the earth? That the ancients could not dream of, for was not the earth solid and fast, firmly set on the bottom of the universe? If you began to picture the sun getting under the earth, nobody knew what might happen next. So they told some remarkable stories of the way the sun got from west to east during the night. Some said it fell into the sea which surrounded the earth, and was quenched by the water, and that the gods then set to work and labored all night making a new sun to start the next morning in the east. But that was too absurd to be believed very long. A great body like the sun could not be used up in a single day. So they said that one of the gods, Vulcan, met it when it set in the west and took it into his boat, and rowed with it very fast all night round the ocean by the north until he came to the east. Then he took it and gave it a toss, starting it on its journey again.

HOMERIC IDEA OF THE SUN PUZZLE

THE SUN-GOD APOLLO

The Greeks saw the sun rise in the east, travel up across the heavens, and sink in the

APOLLO DRIVING HIS SUN HORSES

west, and they thought of it as a god, the great god Apollo. They told how he started in the morning with his chariot drawn by swift horses, and drove with the clouds for his attendants across the heavens and swiftly on towards the golden gate of sunset. Sometimes, they said, Apollo grew weary, and let other gods try to drive his chariot for a day. Then there came trouble and danger for poor earth dwellers; fiery heat and drought when the driver swung the chariot too near, and darkness when the great sun-car was swept out of its right course and clouds shut it from view.

THE WORLD TREE

Up in the Northland men watched the sun rise, and as its rays spread out across the sky they said, "This looks like a tree with branches. Perhaps the world is a tree." So they believed in Yggdrasil, the great World tree. The strong path of the sun was its trunk, the rays of light were its branches, clouds were its leaves, and the sun, moon, and stars were its fruit. This is the description of it from an old German song:

"A gallant tree is growing high,
  A garden gay adorning.
Its roots run down to hell below,
Its crown to heaven above doth throw,
Where God doth sit in golden glow;
  Its branches take the morning:
Its branches spread the whole world through,
Distilling manna, dropping dew,
  And birds thereon are singing."

When you hang gilded nuts and candy animals on your Christmas tree, you do it in memory of this old belief, which has come down to us through these hundreds of years in this German custom. You choose an evergreen tree for your Christmas tree, because the World tree never dies but is ever green, ever living. The gilded balls are for the sun and moon and stars, which hang on the branches, the bits of cotton and tinsel are for the clouds, and the sugar animals are the sacred animals, dear to gods and men, which run up and down its branches.

All sorts of stories were told about these World tree animals. On the branches there was an eagle, and about the roots, gnawing into them, was coiled a great serpent. The eagle and the serpent were always at strife, and a little squirrel spent his time running up and

A TWELFTH CENTURY PICTURE OF THE EARTH AS A TRAY FLOATING ON THE WATERS

down the branches trying to make peace between them. Lightning came in the heavens

because one of the animals ran across the tree. When it was a curving flash, men knew that the serpent had come out; if it was a zigzag flash, the goat was running about. When the old Germans hung their little festival tree, long before they became Christians, they were very careful to put on the tree every one of the sacred animals, for if you forgot and left out one, the god to whom that animal belonged might be angry and send punishment upon you.

So men told stories — one nation one story and one another — about the wonders of the heavens. We who have read further into the book of the heavens than they, find that the true story is far more wonderful than any which men could imagine. The old stories were interesting, but they did not really explain things. They told how things looked, but they could not tell why they looked so. People were not satisfied with them. So wise men all down the ages set themselves to study the stars and find out how to explain their movements. With the working on these questions real star-study began. The Greeks did a great deal of it. It is from them that we take our name for it, *astronomy*, from the Greek word *astron*, meaning "star," and *nomos*, "order" or "arrangement."

Astronomy, then, is the study of stars and their order.

WHAT WAS IT THAT MOVED?

The first question these star students asked was, What was it that moved? Something moved. Anyone who watched the heavens by day or night could see that. But what was it, and how did it move? The more men studied the heavens, the more sure they were that the movements of sun, moon, and stars were regular. The year came round with its four seasons in regular turn, the days became longer and then shorter, the moon came and went at regular intervals. As they studied more and kept records of when these things happened, they found that they could even tell beforehand when these events and many more were going to happen. But how account for it?

The Greek astronomers found out a great deal about the travel habits of the stars, but they could not learn the whole truth, because they thought the earth was set in the center of the universe and could not be moved. They gave up the old idea that nothing could pass under the earth. Some of them even came to think that perhaps the earth was not flat, but curving or partly rounded, like a rubber ball partly flattened out. They made a picture in their minds something like this: The heavens might be a great hollow ball or sphere with the sun and moon and stars tightly fastened to the inside of it. The earth, too, must be fastened somehow, they did not know how, in the center of this hollow space, and the hollow sphere kept turning round the earth, carrying the sun and moon and stars with it.

This was the plan which had for its story the Greek myth of Atlas, the earth bearer, who rebelled against Jupiter, and was condemned in punishment to hold up the world on his shoulders. From him we take our name for a book of maps of the world, *atlas*, a name first used for this purpose by the great map maker Mercator, who called his book of maps an atlas and put on the title page a picture of Atlas holding the world on his back. Atlas stood in the center of the universe, and about him this hollow sphere was constantly turning, to the inside of which the sun, moon, and stars were neatly fastened.

ATLAS

This hollow sphere plan accounted for some sort of movement of sun, moon, and stars. The trouble was that it did not account for it very well. Certain known facts about the time of their movements did not fit into it. For instance, while this plan allowed the sun and moon to move round the earth, it did not make them move in the right time. The sun took apparently a twenty-four-hour day to go round. But then the sun seemed also to take three hundred and sixty-five days to make a circuit

of the stars, while the moon took from twenty-seven to thirty days for a like journey. Ptolemy, an Egyptian, who lived in the second century after Christ, tried to plan it all out. He made a most elaborate and complicated system. Some stars seemed nearer than others; and they all had circles of their own in which they turned. Back of our stars — the stars we could see — he imagined another set of spheres, which made up a great machinery out of sight that managed the movements of our stars. Altogether it was a most impossible scheme. We do not wonder at young King Alphonso X of Spain, who, when he tried to understand it nearly a thousand years after Ptolemy had proposed it, said that if he had been the creator and had been planning the universe, he would have found a simpler way to arrange it.

SEE WHAT A GIANT THE SUN IS COMPARED TO THE OTHER MEMBERS OF HIS FAMILY

This was a rash remark for even a king in those days, for the people might be led to think a man unfit to be a king who spoke so irreverently. But King Alphonso was right. God had set the stars in the heavens after a much simpler plan, a plan discovered three hundred years after King Alphonso's time and about fourteen hundred years after Ptolemy, by the great astronomer Copernicus.

Nicholas Koppernik, whom we know under the Latin form of his name, Copernicus, was born in Poland in 1473, and died in 1543. This was just the period, as you see, when Columbus was trying to convince people that the earth was round. Copernicus was a poor boy; his father was a tradesman. But his uncle was a bishop in the cathedral of Frauenburg, Poland. This uncle took the boy and had him educated, first in the church schools and later in the universities, and he became for a time professor of mathematics in Rome. He did not stay long in Rome, but went back to his uncle's cathedral, becoming a canon of the church, and devoting all the time which was not needed for preaching or visiting the sick to the study of astronomy.

COPERNICUS AND HIS DISCOVERY

Night after night Copernicus sat up in one of the cathedral towers and watched the move-

ments of the stars. He had read all the old books on astronomy, but they did not satisfy him. He realized that Ptolemy's theory was proving more and more impossible, as more facts which did not fit into it were found out. Copernicus watched and watched, and thought and thought, and at last his great idea came to him. Perhaps the earth was not the center of the universe about which everything else revolved, but only one small revolving part of it. Perhaps the earth itself moved. For years and years he worked on this idea, and proved that the earth not only turns round once in twenty-four hours, but is only one of the planets, all of which revolve round the sun.

KING JOHN AND THE CLEVER SHEPHERD

The way this new idea worked out was something like this: The ancients had pictured the sky as a hollow sphere which turned round the earth and carried with it the sun, moon, and stars. Even in Copernicus' day everybody believed that this was the plan of the world. A favorite puzzle question of the time was: "How long would it take a man to go round the earth?" No one had any idea you really could go round the earth, but they used the question as a trick with which to catch people. King John tried it on the clever shepherd, and the shepherd answered promptly, "Twenty-four hours, your Royal Highness." "How do you make that out?" asked the king. "It is very simple," replied the shepherd. "If he rose with the sun and rode along with it all day, in just twenty-four hours he would certainly have been round the world." "Very good," said the king, laughing, "if the sun would take him along, he certainly would. But now I'll ask you another question: What is the center of the universe?" "That is easier still," replied the shepherd; "right here where your Majesty stands, and if anyone is disloyal enough to question it, let him disprove it if he can."

But while the shepherd's wit won him royal favor, this point was just what Copernicus set out to disprove. He thought of it in this way: If you stood still in the center of a hollow ball, and the ball moved round you, from east to west, everything fastened to the inside of it would appear to move in that direction. But suppose the hollow ball stood still, and you inside it were moving, though in the opposite direction, that is, from west to east, would not the effect on you be just the same, especially if you did not know you were moving?

THE SWIFT-SPINNING EARTH

It is very hard to tell which of two objects is moving unless you can compare them with something which is outside them both and standing still. You can readily notice this when you are sitting in a train at a station, and there is another train on the other side of yours. For if one of the trains moves gently, either yours or the other, you cannot tell which one it is unless you look at the station platform; and if your position remains the same in regard to that, you know that your train is still standing, while the other one beside it has begun to move. And it is very likely that there is no one of us who has not, at one time or another, stood on a bridge and watched the water running away underneath until we felt quite dizzy, and it seemed as if the water was standing still and the bridge, with ourselves on it, was flying swiftly away backwards. It is only when we turn to the banks and find them standing still, that we realize the bridge is not moving, and that it is the running water which makes it seem to do so. These everyday instances show us how difficult it is to judge whether we are moving, or an outside object, unless we have something else to compare with it. And the marvelous truth which Copernicus thought out is that, instead of the sun and moon and stars rolling round the earth, it is the earth that is spinning round day by day, while the sun and the stars are comparatively still; and, though the moon does move, yet when we see her get up in the east and go down in the west, that is due to our own movement and not to hers.

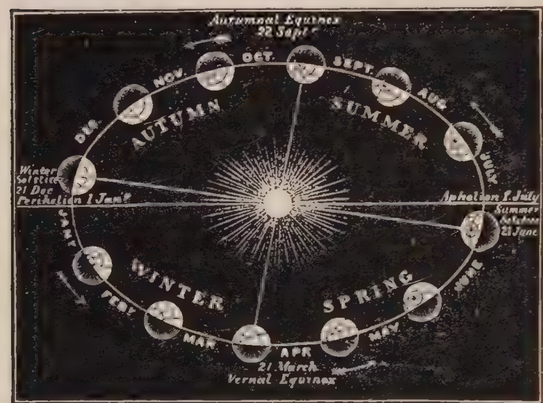
WHY WE HAVE DAY AND NIGHT

When people found this out, they could explain a great many things which had been a puzzle for centuries. One was the old question of "where the sun went at night." Instead of the sun traveling round the earth, it was the earth which moved, spinning round like a top

ASTRONOMERS AND OBSERVATORIES OF THE OLDEN TIMES

once a day, and turning one part of itself to the sun at one time, and the opposite part at the other. It takes the earth just twenty-four hours to spin round once. That is why we have day and night, and also why it is daytime in China, on the other side of the earth, when it is night with us.

If you take an orange and stick a knitting-needle through it, and hold it so that the needle is not quite straight up but a little slanting, and then twirl the orange round and round on the needle, you will get quite a good idea of the way the earth turns round, though of course there is no great pole like a needle stuck through



THE FOUR SEASONS

it. But there is an imaginary line through the earth which takes the place in our minds of the needle, and the points where this line comes to the surface are called the north and south poles.

This imaginary line is called the earth's axis. When astronomers talk of this spinning motion of the earth, they say the earth is turning or rotating on its axis.

WHY WE HAVE FOUR SEASONS IN THE YEAR

Day follows night, and night day, because the earth spins round like a top once in every twenty-four hours. Spring follows winter, and autumn summer, because of another motion of the earth. All the time that the earth is spinning round on its own axis like a top, it is also making a 365-day-long journey round the sun.

You remember that when we talked of the earth as spinning on itself, we pictured it either as a top or as an orange with a knitting-needle stuck through it, and we said that the knitting-needle should be not quite straight up and down, but tilted a little to one side. That was because the earth is tipped in just such a way in its relation to the sun. It is this tip of the earth in its path round the sun which makes our seasons. If the earth were not tipped, if it stood right up straight from pole to pole, there would be no winter or summer, for each part of the earth would be turned towards the sun an equal part of each twenty-four-hour day, and would get about even heat from the sun's rays every day. But it is tipped, and therefore we have winter and summer; and because this tip affects different parts of the earth differently, the seasons are different in the north from those in the south.

EQUAL DAY AND NIGHT

Some tops, mounted in a movable frame suspended on a stand, can be made to spin not only up straight, but with the axis at any inclination. No matter how you move the stand about, the axis of such a top will always point in the same direction, and keep parallel to its first position. This is the way with the earth in its path or orbit round the sun. It spins on its axis always parallel to one direction. Hence, at one part of its journey, during June, the north pole of the axis will be tipped toward the sun, while six months later, in December, it will be tipped away from the sun.

If you watch the sun on March 21st, you will find that it rises directly where the compass points to east, and sets where it points to west. At this time the earth is tipped so that both the north pole and the south pole are equally in line for the sun's rays. Neither is tilted towards the sun more or less than the other. So on this date, day and night will be of exactly equal length in all parts of the world. The sun will be seen above the horizon just twelve hours in every place on the earth's surface. This day is called the *equinox,* which is the Latin for "equal night."

SPRING AND EASTER

March 21st stands to us for the time when spring begins. In the olden days people used

to celebrate this time with great rejoicing, because this equal day and night was the sign that the long, dark winter was past, and spring

HOW A REFLECTING TELESCOPE IS USED

and summer were coming. Our Christian festival of Easter comes at this time, and the early church fathers borrowed for it the name of the old festival of spring, Easter, the festival of the goddess of the East, Ostera, the bringer of spring, who came to earth on this day carrying in her flowing garments gifts of flowers and birds and sunshine.

Spring begins then, because as the earth moves in its path, when it has passed this place of equal days and nights, the northern part — this northern hemisphere on which we in America live — is tipped more and more towards the sun, and so gets more and more sunshine, until on the 21st of June it is tipped as far as it ever can be, and we have our longest possible day, when the sun is above the horizon for nearly eighteen hours.

THE SUN-STAND-STILL

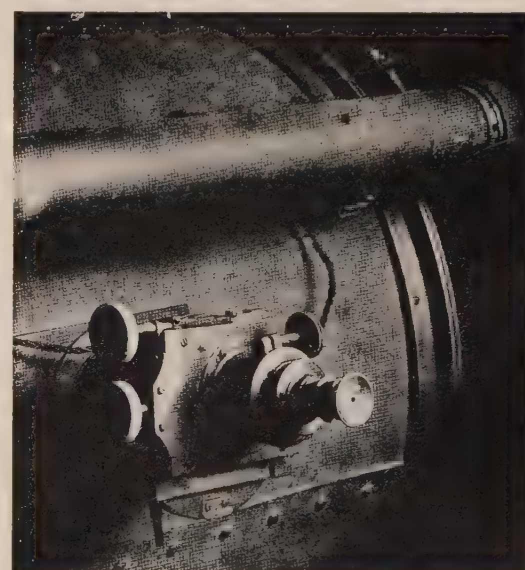
All this time, if you have been watching the sunrise and sunset, you will have noticed that instead of rising due east and due west, as it did on the day of the March equinox, the sun has been rising more to the north of east and setting more to the north of west.

That is because of the earth's tip, which turns our northern hemisphere, during the summer, more towards the sun. On the day — June 21st — when the sun has gone as far north as it intends to, it seems to stand still. That was the way it looked to the Romans, who thought the sun was making the journey, so they called it the summer *solstice*, or "sun-stand-still."

As far back as history goes, men have known about and kept time by these solstices. The Chinese, more than four thousand years ago, used to celebrate the time of the solstice, in the hope of persuading the sun, by their dances and festivals, to delay his departure towards the equinoxes.

WHY WE HAVE AUTUMN AND WINTER

After this longest day of ours, the summer solstice, the earth begins to tip back again, until on the 22nd of September we have the autumn equinox, when once again day and night all over the world are of equal length. The autumn has begun. We know that the days will get shorter and shorter, until on the 21st of December we have our winter solstice,

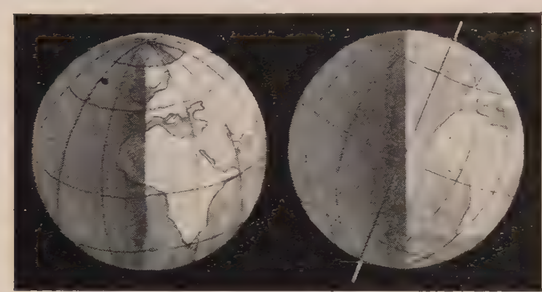


EYEPIECE OF A LARGE REFLECTING TELESCOPE

our shortest day in the year, when the earth has tipped just as far in the opposite direction as it is going to, and we have just as little sun-

light as we ever shall have. Then once more the sun seems to stand still, before the earth starts on the other tip which will bring us back to equal days and nights again on the 21st of March.

Why then, you may ask, do we have the long, cold winter after the 21st of December, and



EQUINOX AND SOLSTICE

the hot summer after the 21st of June? If the earth is beginning to tip back, why do we not feel it at once by warmer weather in January? The answer to that question belongs to another story, of how heat is held by the earth. All we can tell you here is that this earth of ours takes the sun's rays and stores them. If it did not, our coldest day would be just when you would expect it, on December 21st, when we have the sun's rays for the shortest time, and our hottest day would be June 21st, when we have them longest. But the earth and the air have a way of storing up heat and cold and then giving it out slowly, which makes our hottest time and our coldest time come along for a month or two after the solstices.

READING THE SKY-CLOCK

We feel very wise when we have read our first chapter in the book of the heavens and know that the earth travels round the sun instead of the sun's traveling round the earth. Then all of a sudden we find out that, in spite of all this new wisdom of ours, for practical purposes of everyday living we use the movements of the sun, moon, and stars very much as the ancients did.

When you want to know how early it will be light in the morning, or when it will be dark at night, you don't ask at what time the earth will have spun and tipped in its path round the sun so that we shall begin to get the sun's rays, do you? What do you do? You look in the almanac or in the newspaper to find out at what hour and minute the *sun rises* or at what time it *sets*, which is just exactly what the Romans would have said two thousand years ago, or the Chinese two thousand years before that. It is the same sky-clock which we read to tell time, and it marks off our months and days and hours just as it did theirs, though we may call its divisions by different names.

HOW THE SUN TELLS TIME

The earliest way to tell time was by the position of the sun. Primitive man reckoned in two main periods, day and night, and divided day by sunrise, noonday, and sunset. Then he began to divide the morning and the afternoon into sections by noticing the length and position of shadows. He set a stick upright in the ground, and found that the shadow cast by it grew longer and shorter and moved round the stick. This was the origin of the sundial, which is used to this day. By the length and direction of shadows cast by the sun, men could calculate the time to hours and minutes. All ancient peoples told time by sundials. The Chinese had them. The Romans set up tall stone shadow columns, with officers to

A SUNDIAL OF TO-DAY

watch them, whose duty it was hourly to cry out the time as shown by the length and position of the shadows. Even when water-clocks and hour-glasses had come into use in the Middle Ages, the common people, who could not afford such luxuries, told time by sun-clocks, which

Courtesy Harvard College Observatory

TOP: A SMALL PORTION OF THE HEAVENS, AS SHOWN BY PHOTOGRAPHY. BOTTOM: THE 24-INCH REFLECTING TELESCOPE; THE 16-INCH METCALF REFRACTOR, USED PRINCIPALLY IN SOLVING PHOTOMETRIC PROBLEMS RELATING TO STELLAR MAGNITUDES

every father of a family could make for himself. Sometime you must try to make a sundial for yourself; but meanwhile, you and the sun together make up the cheapest and least complicated clock in the world. Study your own shadow, its length, and the way it points, and you will be able to tell from it within an hour the time of day. The Romans did this constantly. Pliny, the great writer, says in one of his letters: "I beg thee to honor my house when thy shadow will be six feet long."

GIANT SUN AND HIS FAMILY

Everybody who lives much in the woods learns how to reckon time by the shadows of the trees.

Shadow-reading is not the best way of telling time, because the sun does not always shine. But shadow-reading is not the only way which depends on the sky-clock. All our modern clocks are regulated by astronomers, who check them up each day by the position of certain fixed stars. The astronomer keeps time for the world, and he takes his time from the sky-clock, the most marvelous clock of all, which through all history has gone with unfailing accuracy, never stopping for a second, never going faster or slower, but keeping steadily on, with the rotating earth for part of its works and the star-set heavens for its face.

THE SUN

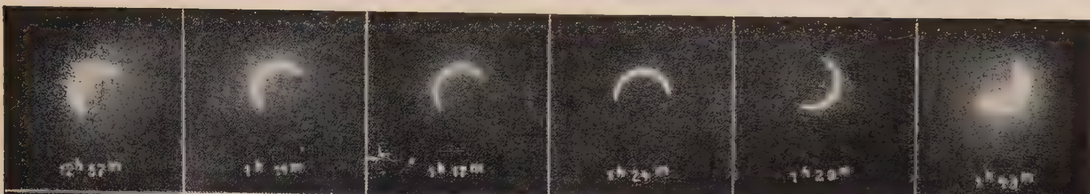
What is this sun, about which the earth revolves, this giant sun on which we depend for light and heat, for day and night and times and seasons, and even for light itself? The ancients worshiped it, and well they might, for there would be no earth or people on the earth if it were not for this light-giving, heat-giving, life-giving sun.

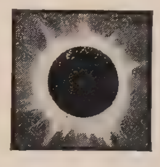
We see it as a great ball of fire, rising higher and higher from the east until midday, and sinking slowly towards the west, where it disappears in a blaze of glory. This is one of the cases where our eyes tell us the truth. The sun is a great fiery ball, giving out to all the worlds about it a tremendous amount of heat and light. More than that we cannot find out until we get some idea of how big this ball is, and how far away it is. These are questions men have been asking since the beginning of time. Only within a few hundred years have they been answered.

SIZE AND DISTANCE

We have seen from our study of the earth's motion how hard it is to tell what is moving and what is standing still. It is just as hard to judge how big an object is and how far away it is. Did you ever ask a group of people on some summer evening to tell how large the moon looked to them? Try it some night. One person will probably say that it looks the size of a cart-wheel to him; another will speak up at once and say, "Oh, no, it doesn't look nearly so large as that to me. I should say a dinner-plate"; another will say a face, and someone in the group may insist that it looks no larger to him than a cent. Probably no two persons in that company will agree on the size which the moon appears to be. Yet they are all looking at the same moon; and what is more important, they are looking at it from the same place at the same time. So, first, in our star study as in all other study of the world in which we live, we have our human eyes to reckon with, and well as they serve us, we have to check up what we seem to see by measures and tests to make sure it is quite true.

Try another experiment with the moon. Close one eye and hold a silver quarter at arm's






THE SUN AND ITS CROWN, PHOTOGRAPHED DURING A TOTAL ECLIPSE

length between the other eye and the full moon. The silver quarter will shut out the great bright globe entirely from your sight. Still you don't really think that the moon is smaller than a silver quarter. Why is it, then, that the quarter can shut out the moon? It is because you put the quarter so close to your eye. A very small thing held close to your eye can shut out a very big thing at a distance from your eye; and a very small object can look very, very tiny if it is far enough away. You know how that is if you have ever stood on top of a mountain and looked down to try to find a house and street in the valley. The house seemed very large to you when you were beside it, but now it is only a tiny dark speck. So, at the very beginning of our story, we learn that things are not always just as they seem to be, and that a small globe close at hand may look as large as a very big one far away.

When we come back to the sun, we have to think of all this, for the sun is really a giant star, tremendously big, but no bigger than and even not so big as some of the other stars in the heavens; and tremendously far away, but still not so far away as some of the other stars.

HOW FAR AWAY IS THE SUN?

Quite lately men have been able, with the help of wonderful instruments, to find out how far away from the earth the sun is. What do you think they found? The distance of the sun from the earth is about *ninety-three millions of miles!* Can you picture that to yourself?

Try to think what is meant by a thousand miles. Our earth is eight thousand miles in diameter. In other words, if you were to thrust a gigantic knitting-needle through her body, from the north pole to the south pole, it would have to be about eight thousand miles long.

To reach the thought of one million, you must picture *one thousand times one thousand.* Our earth is about twenty-five thousand miles round. If you were to start from the mouth of the Amazon River in South America, and journey straight round the whole earth on the equator till you came back to the same point, you would have traveled about twenty-five thousand miles.

But that would be a long way off from a million miles. You would have gone only once round the earth. Now a rope one million miles in length could be wrapped, not once only, but *forty times* round and round the earth.

And when you have managed to reach up to the thought of one million miles, you have then to remember that the sun's distance is ninety-three times as much. So to picture clearly to ourselves the real meaning of ninety-three millions of miles is not easy.

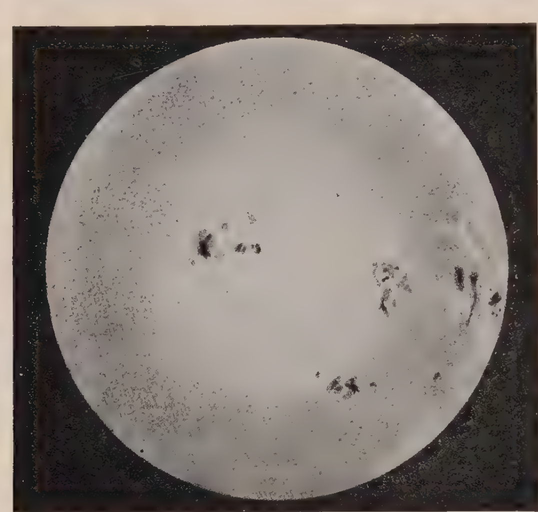
Suppose it were possible to fly by aeroplane from here to the sun. If you could journey thither in a perfectly straight line, at the rate of forty miles an hour, never pausing for one single minute night or day, it would take two hundred and sixty-five years to reach the sun. Make your aeroplane rush through space at a rate of a mile a minute, or sixty miles an hour, and you might hope to reach your journey's end in one hundred and seventy-seven years. If you had started in the year of the Declaration of Independence, you would not have reached the sun yet.

If you had to pay for your journey at a rate

of two cents a mile, it would cost you nearly two million dollars.

THE SIZE OF THE SUN

So much for the sun's distance from us. Now as to its size. The earth is eight thousand miles through from pole to pole. This sounds a great deal; but the distance through the sun is eight hundred and sixty-five thousand miles.



THE SUN'S SPOTS

Suppose you had a long, slender pole which would pass through the middle of the earth, one end just showing at the north pole and the other at the south. You would need more than one hundred of such poles, all joined together, to go through the sun. But, after all, we cannot really understand either how big the sun is or how far he is away from us, for our minds refuse to take in such great figures.

SUN SPOTS AND WHAT THEY TELL US

What is the sun really like? It is hard to tell, for we cannot look straight at the sun because of its dazzling brightness. But a telescope shows us a great deal. Only remember that you must never look at the sun even through a telescope without protecting your eyes with colored glass, else you will be very likely to blind yourself, or hurt your sight very badly. When we first look at the sun through the telescope (which is a long tube so fitted with mirrors and glasses that it helps us to see things which could not be seen with the naked eye), it looks like a broad, round, white disc, shaded a little at the edge, so that you can see it is not really flat, but a globe. And here are two or three little black splashes upon the whiteness, looking as if somebody had spilt some ink on the paper. Now, these black splashes are the famous sun spots which tell us so much about the sun. They do not look very wonderful, do they? But let us try to think what they really are like. They measure often many thousands of miles from side to side, and some of them are so big that you could lay ten worlds upon them in a row, and still the spot would not be altogether covered.

In the beginning of the seventeenth century a man named Fabricius was startled by the sight of a certain black spot upon the face of the sun. He watched till too dazzled to look any longer, supposing it to be a small cloud, yet anxious to learn more. Next day the spot was there still, but it seemed to have moved on a little way. Morning after morning this movement was found to continue, and soon a second spot, and then a third spot, were observed creeping in like manner across the sun. After a while they vanished, one at a time, round his edge, as it were; but after some days of patient waiting on the part of the lookers-on, the spots appeared again at the opposite edge, and once more began their journey across.

Fabricius seems to have been the first, but he was not the last, to watch sun spots. Many astronomers have given close attention to them. Modern telescopes, and the modern plan of looking at the sun through darkened glass, have made this possible in a way that was not possible two or three hundred years ago. For more than thirty years one astronomer kept close watch over the spots, on every day that it was possible to see the sun. Much has been learned through his resolute perseverance.

WHAT ARE THESE SPOTS?

No one can actually say what they are. Some astronomers think they are great hollows in the sun's surface, where the stuff which he has thrown out, and which has got cooled, is gradually settling down again. But this is not at all

UNBELIEVABLE TIME REQUIRED TO COV

TO SUN
88½ years

—

Start now and you would not get there till after 2000 A.D. Yet light gets here from the sun in eight and a third minutes

TO MERCURY
54 years

—

News of the World War not due there till 1968

TO MARS
46½ years

—

A man would grow old on the way

TO VENUS
25 years

TO MOON
83 days

IF MAN SHOULD INVADE SPACE — A RACE FOR SUN, MOON, AND PL

Man has invaded space — not in airplanes which would fall to pieces with age before Earth's near neighbors were visited own tiny planet, an infinitesimal atom in a boundless universe, he can with cunningly contrived pieces of glass bring man tell their distance; by splitting up their faint rays of light, he can judge of what they are made. Though they be a million sugar. Keeping track of their movements, he can tell where they will be hundreds of years in the future.

IMMENSE DISTANCES OF SPACE

TO JUPITER
372 years

—

From the year of the discovery of America to the close of the Civil War

TO SATURN
755 years

—

It takes his light over an hour to get to us

TO URANUS
1610 years

—

Starting long before Rome fell, you would be going still

TO NEPTUNE
2571 years

—

If we had started six hundred years before Christ, we should be drawing near Neptune

TO THE STARS

Millions and millions of years

TS AT THE TERRIFIC SPEED OF TWO MILES A MINUTE

ith thoughts which travel faster and work more miracles even than the light of the sun. Standing on his
s of other worlds to him, and make them tell him their story. By measuring the speed of light, he can
as big as he, yet standing on his little spot of earth, he can weigh them as he would weigh a pound of

certain. All we can say is that the spots are caused by great storms and eruptions within the sun, and that they tell us that this great globe is not solid and steady, like the earth, but is constantly tossing and heaving up and down, almost like water boiling in a kettle.

If you look at a sun spot for several days, you will notice that it is always changing. In a day or two it might look quite different from what it did at first; sometimes the changes come so quickly that parts of the spot as big as our world alter their shape in a few hours. So you see that the sun can scarcely be a place that you would like to live in. Even if you could stand the heat, which would melt in a moment the hardest things we know of, you would find that there was nothing solid to put your feet on. Great fiery waves would always be rising and falling around you; every now and then jets of flame would shoot up thousands of miles high; and sometimes huge gulfs, in which worlds might be swallowed up, would yawn beneath your feet.

HOW WE KNOW THAT THE SUN TURNS ROUND

You will see, however, if you watch a spot carefully, that another kind of change is taking place. It is near one edge of the sun at first. Next day, it will be a little nearer the middle, and, in about twelve and a half days from the time it first appeared, it will be going out of sight at the edge opposite to that where you first saw it; while, if you wait another twelve and a half or thirteen days, you may see it coming back again just where it first appeared. Do you understand what that means? Remember what we found out about the time it took the earth to spin round once. When a sun spot takes twelve and a half days to go from one side to the other, and another twelve and a half to come back into sight again, that means that the sun turns round in twenty-five days, just as our world does in twenty-four hours. The first important discovery made through the spots on the sun was that the sun turns round upon his axis in just the same manner that the earth turns round upon hers. Only — and this is the strange thing — the sun does not turn all at the same speed. Our world spins round all in a piece, and, if it did not, it would probably fly all to bits; but some parts of the sun take twenty-five days to turn round, some take twenty-seven, and some take longer still.

CHANGEABLE SPOTS AND THE "LITTLE TORCHES" OF THE SUN

It must not be supposed that the spots seen now upon the sun are the same spots that Fabricius saw. There is perpetual change going on — new spots forming, old spots vanishing; one spot breaking into two, two spots joining into one, and so on. Even in a single hour great alterations are sometimes seen to take place. Still, many of the spots do remain long enough and keep their shapes closely enough to be watched from day to day, and to be known again as old friends when they reappear, after being about twelve days hidden on the other side of the sun. So that the turning of the sun upon his axis has become, after long and careful examination, a certain fact.

There are other marks on the face of the sun, which you would notice at once through the telescope. Near the edge, and generally close

A SUN SPOT, SHOWING CRATERS

to a spot, you will see white markings of all shapes and sizes, looking as if they were the crests of the fiery waves thrown up by the solar storms. Astronomers call them *faculæ*, or "little torches." And all over the surface there is a beautiful delicate mottling of gray and white, which sometimes makes the face of the sun look rather like a plate of rice soup.

THE SUN A BUBBLE

Thus the sun is very different from what you would imagine when you see it shining day by day. Indeed, if we thought of it as a great bubble we would not be very far wrong. Of course, this is such a bubble as you never dreamed of — a bubble far bigger and heavier

THE EARTH AS SEEN FROM THE MOON

than all the worlds that go round about it put together; a bubble which, instead of being made of soapsuds, is made of iron, lead, lime, and all sorts of other things, heated so hot that they have become glowing gases. Think how enormous the heat of this tremendous bubble must be! We sometimes feel the sunshine uncomfortably hot on a summer day, but we may be thankful that the sun is so far away from us, for if it were to come even as near to us as the moon does we should scarcely have time to feel uncomfortable. We should simply shrivel up and vanish, and our solid world would melt, like a drop of wax in the flame of a candle.

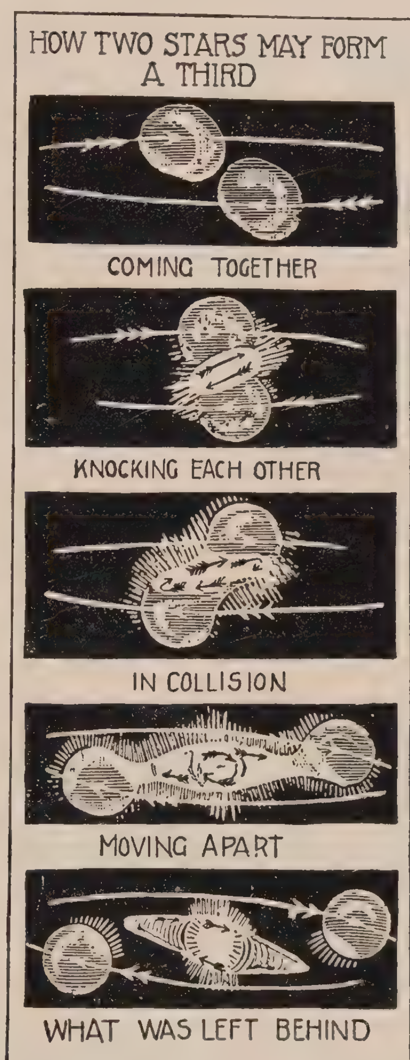
WHAT KEEPS UP THE FIRES IN THE SUN

For thousands and thousands of years this tremendous flood of light and heat has been pouring out from the sun. How does he keep it up? What can stoke the furnaces that produce such a continual glow? Mere burning can never account for such heat. It is true that the sun is so enormous that he might go on burning for a very long time without burning right away; but then, even if he is huge, his expenditure is also huge. If he had been made of solid coal, he would have been all used up in about six thousand years, burning at the rate he does. Now, we know that the ancient Egyptians kept careful note of the heavenly bodies, and if the sun was really burning away he must have been very much larger in their time; but we have no record of this; on the contrary, all records of the sun even to five thousand years ago show that he was much the same then as at present.

Yet how can the sun give out heat except by burning? The answer brings us back to the earth. Right here in our own experience we can find, if we look for it, heat that is made in other ways than by burning. Heat is only a form of force or energy, and energy and heat can be interchanged easily. This is a very startling thing when heard for the first time, but it is known as surely as we know anything, and has been proved again and again. When a savage wants to make a fire, he rubs a piece of hard wood swiftly between his palms, pressing one end into a hole in another piece of wood, until a spark bursts out. What is the spark? It is the energy of the savage's work turned to heat. When a horse strikes his iron-shod hoofs hard on the pavement, you see sparks fly; that is caused by the energy of the horse's leg. When you pump hard at your bicycle, you feel your pump getting quite hot, for part of the energy you are putting into your work is transformed into heat; and so on in numberless instances. No energetic action of any kind in this world takes place without some of the energy being turned into heat, though in many instances the amount is so small as not to be noticed. Just so the great sun bubble is making heat by *shrinking*. When a train comes into the station, and the brakes are put on, the sparks that fly from the wheels tell you that heat is being produced. The motion of the train and the force that stops it are being turned into heat. Now, if the sun shrinks, as we know it does, its outer layers are constantly pressing upon the inner ones, just as the brakes press upon the

wheels of the train, and that pressure is always making heat. Indeed, if the sun shrinks only two hundred and fifty feet in a year, that will supply it with all the heat it sends out in that year.

But the sun is so enormous, and the amount of shrinking every year is so small, that it would take nearly ten thousand years before we could tell, even with our finest instruments, that he had grown any smaller. And if we try to think of a time when he will no longer be able to supply us with as much light and heat as we get from him now, we find that we must measure that time by millions of years. So we need not be afraid that there is any risk of the sun's furnaces going out meanwhile. He will last our time, and a good deal more.



AN IMAGINARY BATTLE BETWEEN STARS

WHEN STARS COLLIDE

Once in a while stars explode or collide and make such a blaze that we see what looks like a new star in the heavens. In the year 1901 a new star appeared in the sky. It increased in brightness until at the end of the third day it was twenty-five thousand times as bright as when it first appeared. Then it began to fade, and in six months could be seen only through a telescope, and later only very dimly.

About thirty of these stars, called *novæ*, from the Latin word for "new," are on record since the astronomers began to keep records. This 1901 star, Nova Persei, was the brightest since 1604. It must take a tremendous heat and shock to make such fireworks in the sky. This is one of the theories as to what happened. Almost all the stars we see are suns, made up, as our sun is, of hot gases. Two of them must have come together hard and knocked pieces off each other. They must also have made a fearful amount of heat in the act of hitting each other. The result was that a new star-body was left behind where the two had passed. It has been figured out that if two stars, moving at a rate of one hundred miles a second, hit each other, they would make a temperature five hundred times as hot as the boiling heat of water. These stars that ran into each other and made the star of 1901 seem to have been going even faster.

They met, knocked big pieces of star-stuff off each other, left it burning in a kind of fiery mist, and went along, scarred but not destroyed. The star-mist, Nova Persei, either was not big enough or did not move fast enough to make a star that would last. This is, of course, only a guess and a good story, and astronomers are now inclined to believe in the theory of star explosion rather than in that of collision.

NEWS THREE HUNDRED YEARS OLD

But when did all this happen? In 1901, you say. No, not at all. We call Nova Persei a new star in 1901, but it has been dead matter for three hundred years. This event took place so far away that it has taken the light of that star-shock, traveling at the rate of one hundred and eighty-six thousand miles a sec-

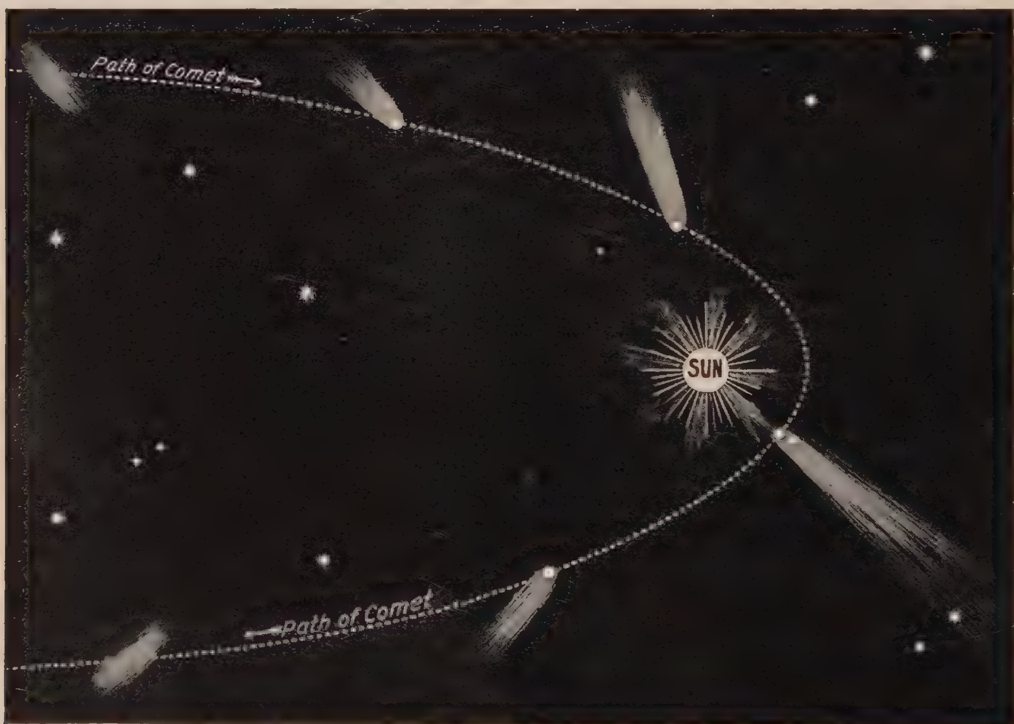
ond, three hundred years to reach us. Think of it as if it were a rocket sending out sparks. The sparks were caused by a star-meeting in

PHOTOGRAPH OF SUN SHOWING SUN SPOTS

about the year 1600. The new star lived a few weeks as a shining body. Light-waves started at once to bring us news of this fearful accident, but they had such a long way to travel that we did not "see the sparks" until 1901.

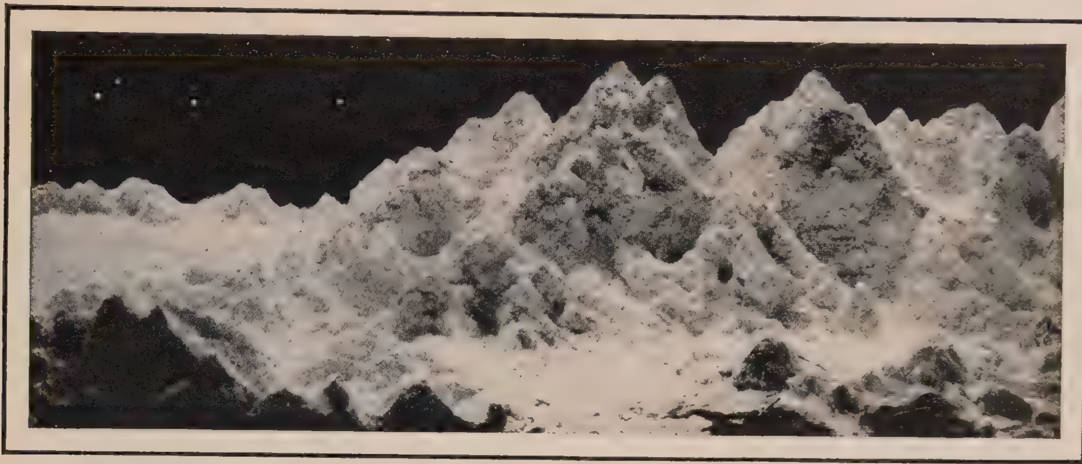
The sun is the only heavenly body which we see by day, but this does not mean that the sun is the only one which is shining by day. The moon and the stars are shining just the same; but the sun is so bright that it outshines them all. Sometimes in the late afternoon you can see the moon shining faintly, and once in a while you can even see a few stars; but it is only when the sunlight has been gone an hour or two that we can really see the moon and stars in their brilliance.

The strange part of it is that while on earth we can see farther by day than by night, when we turn to look at the heavens we can see much farther by night than by day. No one knows how far we can see at night; but some of the stars which we see when we go out after sunset and look for the first stars are either those which seem bright to us because they are near, as star-distances are reckoned, or they are very large stars. The moon looks largest



THE OUTWARD PRESSURE OF THE SUN

When a comet is far from the sun it appears a shapeless patch of light, but as it approaches it develops a streaming tail of light that looks as if it were blown away from the sun, owing to the repelling power of the sun.



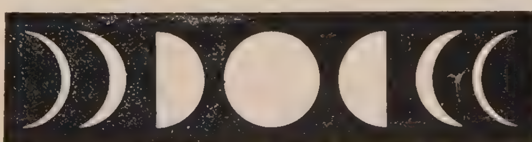
SOUTH POLE MOUNTAINS ON THE MOON, AS SEEN THROUGH THE TELESCOPE

of all to us — not because the moon is itself very large, the moon is only a tiny ball compared to some of the stars — but the moon is nearer to us than any other one of the shining worlds which float in the heavens. She is our nearest neighbor in space.

THE MOON AND THE EARTH

Not only is the moon nearer to us than the other stars, but it really belongs to us. It is our moon. Jupiter has moons. Other planets have moons, though much smaller ones than ours; and this is our moon, our attendant, or as the astronomers call it, using the Latin word for "attendant," our *satellite*. Just as we move round the sun in a path which it takes us 365 days to travel, so our moon which, big as it is, is quite small compared to the earth, moves round us once in every twenty-seven days; and that is where we get our months. So the moon is part of our sky-clock, too; only, while the sun gives us our days and hours, seasons and years, the moon divides our time off into months.

There is another reason why the moon belongs to us. It used to be a part of us. Once upon a time, the astronomers say, the earth was not a solid, hard, round body, such as she is now, but much larger and softer, and as she turned round and round in her course, a fragment broke off from her. This fragment was our moon. It did not go right away from the earth, but still went on circling round with the motion which it had when it was a part of her. As the ages passed, the earth and this wandering piece, both of which had been very hot, cooled down, and in cooling became smaller, so that the distance between them was greater than it had been before they shrank. There were other causes also that tended to thrust the two farther from each other; till now they are 240,000 miles apart, and getting farther apart all the time. Astronomers call this very close indeed, and so it is, compared to the distances of sun and stars; but if we were not thinking



PHASES OF THE MOON

in star-distances we should call it very far. It is 25,000 miles round our world. If a man starts to travel round the world, even with our fast ships and trains, he must allow fifty or sixty days to make the circuit. But if when he arrived at his starting-point he set off once again, and then again, until he had been round ten times, he would then have traveled only as far as from the earth to the moon. But if any kind of traveling would ever bring him to the moon, he could go round it in much less time, for one journey round the earth would equal about four round the moon.

WHY THE MOON SEEMS TO CHANGE HER SHAPE

The sun seems always round and bright, but the moon is always changing her shape. You see her first as a thin crescent of light, quite close to where the sun has set. Night after night she grows broader and rounder, till she is quite full — a great silvery globe rising in the east as the sun sets in the west; and after that she gradually loses her roundness again, till you see her in the early morning before the sunrise, a pale crescent, with her horns turned the opposite way from those of the evening crescent.

Now the moon does not really change her shape any more than our earth does. The reason she seems to is because she borrows her light from the sun. Strange as it may seem, the moon has no light of her own. She gets it all from the sun, just as we on earth do. It is only because the sun gives light to the moon, and the moon is kind enough to pass it on to the earth, that we are not left in the dimness of starlight all the nights of the year. The moon has no light of her own because she has no heat of her own. She has no glowing flames from which to shed light, as the sun does. But she can reflect the light which the sun sheds on her, and this is the way she does it. The moon is always lit up by the sun. But just as we who live on one side of the earth cannot see the sun all the time, so, as sun and moon turn round, only part of the moon gets the sunlight at one time. Again, the way the moon turns round us, she does not ever show all of herself to us, but she keeps one face, one side of herself, towards us all the time. Sometimes this face is all reflecting sunlight, sometimes only part of it. The part of the moon which we see shining brightly is that section of the moon's surface which is both lighted by the sun and also turned towards us. Half the moon's surface is lighted by the sun at the very time when we are seeing only the crescent moon, but it is not the half which is turned towards us. Only that section of *our* side of the moon which is being lighted by the sun shows to us. The other part is in shadow.

When we see the moon first in the western sky above the sunset, it is a slender crescent of silvery light, and is about two days old. That is, it is about two days since the moon passed between the earth and the sun. Night after night it grows in size, until about five days after we see it first, it is half full. Then at sunset it has made half its daily journey across our sky, and has reached what almanacs call its "First Quarter." It continues to grow for

Courtesy Harvard College Observatory

MOON CAVES AND MOUNTAINS

about another week, until one evening it is our full moon. It rises just as the sun sets. The half facing us is fully lighted, for exactly the same half is facing the sun. Then slowly its size decreases. It rises later and later, and grows smaller and smaller, until when it reaches its "Last Quarter" it is to be seen only in the morning hours. The moon is going back to its place between the earth and the sun; for about a week of this time it is out of sight.

THE EARTH AND THE MOON HANGING IN SPACE, AS SEEN FROM VENUS

MOONSHINE AND EARTHSHINE

But sometimes we can see the crescent moon, and also very, very faintly the outline of the full moon back of it. That is what people mean when they talk of "the old moon's lying in the new moon's arms." The bright crescent is being lighted by reflected sunlight. But what then is giving this light to the other part of the face, which would naturally be in black shadow? That light comes from our earth. This is one of the sights in the heavens which reminds us that we too are a shining globe floating in space and appearing bright to others while they are shedding their light on us. Like the moon, we borrow our light from the sun. The sun's rays strike us and are reflected to the moon, just as they strike the moon and are reflected to us. While the earth is being lighted by moonshine, the moon is being lighted by earthshine; and from the moon the earth must appear a much bigger and more glorious sight even than the moon does to us, for we are forty-nine times as big as the moon, and four times as wide across. If there were people on the moon they would see the earth sometimes "full" and sometimes "half-full." They would speak of "full-earth" and "half-earth." The earth is also turning different parts of its surface to the moon while spinning on its axis, and while the moon travels round it. So when we see this faint outline of the moon full outside the crescent, it is the reflection of our own earthlight coming back to us.

THE MOON A DEAD WORLD

We cannot go to the moon, and perhaps it is just as well, for astronomers tell us that if we went there we could not live for a single instant. The reason would be that there is no air around the moon. All round the surface of our earth there is a great blanket of the air we breathe; but the moon is a dead world.

If there is one thing we have found out certainly about the moon, it is that no life, as we know it, could exist there, for there is neither air nor water. Whether she ever had any air or water, and if so, why they disappeared, are questions we cannot answer. We know only that now she is a dead world. Bright and beautiful as she is, shedding on us a pale, pure light, in vivid contrast with the fiery yellow rays of the sun, yet she is lifeless and still.

FIGURES IN THE MOON

One sign that the moon is a dead world, without air surrounding it, is that it looks so clear to us. Clouds sometimes come between us and the moon, but they are earth-clouds. There are no moon-clouds because there is no air. So the moon, when we can see it, is always clearly outlined against the sky. It is a perfect crescent or half moon, not a disc that shades off into space or into bright rays, as the sun does. Another sign is that we can look at it at all. If the moon had flames of its own like the sun, and were so near us, not only could we never look at it; probably we should not be a world at all, for a blazing body so near us would have burned us up long ago.

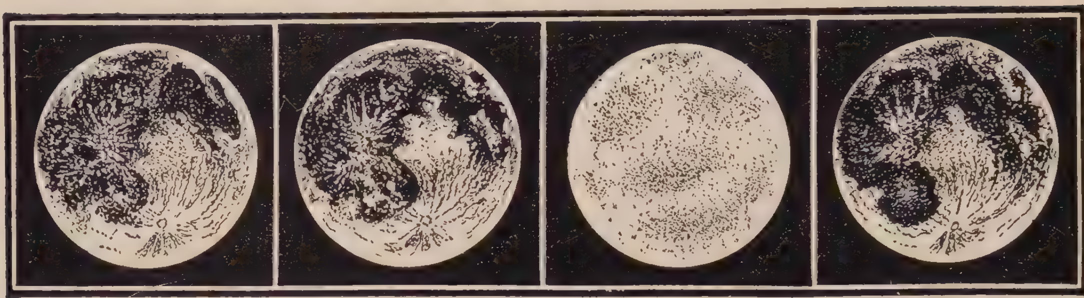
When we do look, what do we see? As it grows from crescent to full, dark patches begin to show on it. It does not look all smooth and even and equally bright, but bright in one place and shadowy in another. These dark and light spots seem, as we look at them, to make great faces and figures, and because the moon keeps the same face towards us all the time, they are always the same, and have been for thousands of years. The biggest face is the one we see when the moon is full or almost full, and we call it the "Man in the Moon." People in the olden days saw this man, and another man, too, the whole figure of a man with a bundle of sticks on his back. This is the story they told about him.

HOW THE MAN CAME TO BE IN THE MOON

One Sunday morning an old man went to a forest and cut some sticks, and made them up into a bundle and put them on his back. As he was trudging home, an angel met him and said: "Why do you work? Do you not know that this is Sunday on earth, when all men rest from labor?"

"Sunday on earth or Monday in heaven, it's all one to me," said the old man.

"Then," said the angel, "as you do not keep Sunday on earth, you shall live in a place where



RABBIT-MOON LADY-MOON MAN-MOON UPSIDE-DOWN MAN

it is Monday (Moon-day) all the time. You shall carry your bundle of sticks with you, and keep them on your back until the end of the world."

The old man rose up to the moon, and there on a clear night you can still see a great shadow, as of a man with a bundle of sticks on his shoulder.

THE RABBIT IN THE MOON

On the west side of the moon there is a great dark patch which looks like a rabbit. He is very interesting, for it is because of him that we have rabbits at Easter.

Easter is decided by the moon. It does not come on the same date every year, as Christmas does, but it is appointed by the times of the moon. Easter always falls on the first Sunday after the first full moon following the fixed date of the 21st of March, which you will remember is the day of the spring equinox. Because the moon decides when Easter shall come, Easter belongs in a way to the moon, and the moon's little rabbit comes hopping along at Easter time to remind us of this.

The rabbit did not always live in the moon. He was a little earth rabbit who lived in India. One day he and a duck, a monkey, and a fox decided to retire to the wilderness together and lead a religious life. That was one way to be religious in India, to go away and live alone and try, by keeping your mind off worldly things, to become good. So the four journeyed into the wilderness, and before they separated each took a vow to kill no living thing.

When the animals had been in the wilderness a little while, the god Buddha decided he would try their faith and see how good they had become. He came down to earth and took the dress and form of a religious pilgrim and went to beg alms of each.

First he came to the monkey, and he said, "Friend, I have journeyed far without food. I pray you, give me some refreshment, that I faint not by the way."

"Gladly," said the monkey, and he climbed up into the nearest trees, and picked fruit, oranges and mangoes, which he brought down and set before the weary traveler.

Next the pilgrim went to the duck, and to him he said, "Friend, I have journeyed far, and am in need of food. I pray you, help me, that I faint not by the way."

And the duck said, "I have nothing here, but as I came along the river bank I remember seeing a string of fish, forgotten by some fisherman. I will fetch them."

The pilgrim ate and was refreshed, and went on his way till he came to the home of the fox. Of him he made the same request. The fox had nothing to serve him, but when he went out to look for something, he came, before he had gone many steps, upon a pot of milk and some dried meat, which had been left on the plain by some herdsman. With these he returned to the pilgrim and gave him a very good meal. So each of the three kept his vow to kill no living thing, without particular trouble to himself, beyond the mere going out and looking for food.

But when the pilgrim presented himself, tired and hungry, before the rabbit and asked for refreshment, the rabbit could only say, "Friend, I eat nothing but grass, and I fear that will be of no use to you."

"But to help those who are in need and to

offer hospitality are two of the duties of the hermit," replied the pilgrim.

"Yes," said the rabbit sadly, "but I have made a vow to kill no living thing. What can I do?"

"If you are a truly religious hermit, you can give your own flesh, for to give yourself for another's need is the highest sign of the holy life."

"That I will do willingly," replied the rabbit.

So the pilgrim built a little fire beside a rock, and the rabbit prepared to jump from the rock down into the fire, to be roasted for the tired pilgrim.

But as he jumped, before he touched the fire, it was put out. Buddha took again his rightful form as a god, and caught the rabbit in his arms and took him to the moon, so that every living creature in every part of the other worlds might see him and remember the kindly deed of the little rabbit.

THE MOON MAIDEN

There are other faces, however, to be seen in the moon, which we should notice before we leave her. There is a smaller face, quite marked and easily seen if you have good eyes. It lies about the middle of the full moon, and you may try to pick it out for yourself. Some people find a donkey, and others a girl reading; but these are not quite so easily seen. The Chinese say that the markings represent a monkey pounding rice; while the Persians say that the moon is like a great mirror, in which we see the reflection of the seas and continents of our own world. Perhaps the most interesting of all the faces is this one, called the "Moon Maiden." It can be seen only when the sun happens to shine upon it in exactly the right way. Perhaps some fine night you may get a chance to see this face of the Moon Maiden, with her long hair floating behind her, looking out from the cape of the Bay of Rainbows across the Sea of Showers.

There is a "Moon Lady," also, easily seen when you have once found her, and very attractive, although her nose is turned up a little. Our artist has shown the Man, the Lady, the Maiden, the Rabbit, and the Upside-down Man.

WHAT IS THE "MAN IN THE MOON"?

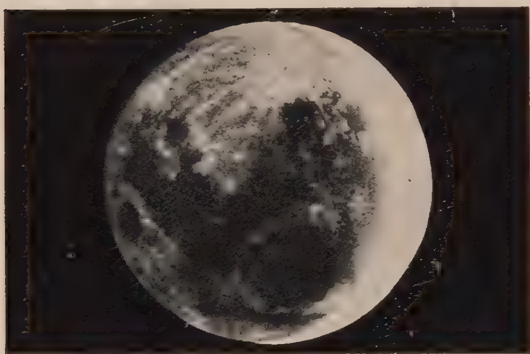
What is the "Man in the Moon"? What is it on the moon's surface which makes these light and dark places which look from the earth like faces and figures? If we look through a telescope, we see them very differently. But first let us picture ourselves standing outside both earth and moon on another star,—perhaps the planet Venus, for it is in a position which would give us a good view.

Now if we should happen to stand upon the planet Venus, and her veil of cloud were drawn

THE MOON MAIDEN WITH FLOWING HAIR

aside to give us a clear sky, we should see a very pretty sight. Shining brightly against the dark background of the sky would be what seems a double world, made up of one big, bright star and a smaller star quite close to it. If we had a telescope, we should be able to make out a great many features of the bigger star. We should see that it had glittering white

ice-caps at the poles, and that its whole surface was flecked over with patches of brown and green and blue; while here and there brilliant white patches would come and go, blurring the outlines of the other parts. We should see this prettily colored world turning steadily round and showing us different aspects of its surface; and all the time the smaller world



CRESCENT MOON
Dark portion photographed by earthlight. (Shaded in copying.)

near it, which we would not be able to see quite so well, would be circling round the bigger one. The bigger world is the earth we live upon, and the smaller one is the moon; and the two together would make one of the prettiest pictures you can imagine in the sky of Venus.

We never can see ourselves as others see us in that fashion, yet, fortunately, we can get a better view of the moon than of any other body in the heavens, and we can see many most interesting and wonderful things upon her surface. Indeed, even a small telescope will show you quite a number of them, and it would be well worth your while to try and see them for yourself. When you use a telescope, the face of our old friend, the "Man in the Moon," vanishes, and you see a great round silvery globe, very bright in some parts and very gray in others, and altogether looking not unlike a badly peeled orange.

MOON MOUNTAINS

The best time to study the moon is not at full, but when she is half bright and half dark, a week or ten days after the new moon. Suppose we turn a telescope on her when she is like that. When you put your eye to the eyepiece, you find that the moon has grown so big that it can't shine through the telescope all at once, and you have to take it in bit by bit. Look, now, at this piece near the middle of the flat edge. You see it is all full of great black holes, or, rather, it is all covered over with bright rings, which are full inside with black shadow, and look almost like the little cells in a piece of honeycomb. The black shadows are the mountains in the moon, and very strange and wonderful mountains they are.

You know what a volcano is. We have some volcanoes on our own world — burning mountains that throw up fire and smoke, and sometimes ashes and lava. Well, these ring mountains on the moon seem once to have been volcanoes like Vesuvius or Etna. The rings are their craters.

A crater is like a cup, and generally has a little peak in the middle of it. This is the summit of a volcano, and when the volcano has burst and vomited out its floods of lava and débris, this has fallen down in a ring a little distance away from it, leaving a clear space next to the peak, so that, as the mountain ceases vomiting and the lava cools down, the ring hardens and forms a circular ridge. The craters on the moon are immense, not only in proportion to her size, but immense even according to our ideas on the earth. One of the largest craters in our own world is in Japan, and this measures seven miles across, while in the moon craters of fifty, sixty, and even a hundred miles are by no means uncommon.

A WORLD OF DEAD VOLCANOES

All these mountains and craters show that at one time the moon must have been convulsed with terrific disturbances, far worse than anything that we have any knowledge of on our earth. When they were all burning, the moon must have been a most wonderful place, but very uncomfortable to live upon; for we have known enough about the ruin wrought by volcanoes in our own world to be glad that we have so few of them. In the moon, of course, they are all burnt out now, and no more smoke or fire ever comes from them.

OUR WONDER WORLD, AS IT MAY LOOK FROM A NEIGHBOR PLANET

OUR WORLD, WITH ITS AMERICAN CONTINENTS SHOWN IN RELIEF, AS IT SWINGS THROUGH SPACE, AND AS IT MAY POSSIBLY BE SEEN FROM MARS OR VENUS

Volcanoes are not the only mountains on the moon. Here and there are long ranges of mountains, stretching sometimes for hundreds of miles across the surface. If you look through the telescope, you will see a long, curved streak stretching down from below the middle of the moon to the flat edge. That is one of the moon's mountain ranges, called the "Lunar Apennines." You can see it quite well on the full moon with the naked eye, and it makes the nose of the man. But when you look at it with a telescope, you see the great peaks, some of them higher than Mont Blanc, shining almost as white as if they were covered with snow, and the long, black shadows which they cast stretching for many miles across the plain. These shadows are far blacker than any darkness that you ever saw on the world; for all our earthly shadows are softened and made lighter by the presence of our air, but on the moon there is no air at all, or, at least, next to none.

Then there are great, dark places, which by the absence of shadows we know to be plains, hundreds and hundreds of miles wide. These are some of the great dark splotches we see. There are, also, tremendous clefts in the ground, some of them hundreds of miles long, and so deep that no one can tell how deep they are. You have seen the ground cracking in hot summer weather, and opening up into long clefts. Well, these cracks on the moon look very like that, and they were probably caused by the surface splitting as it cooled down from the tremendously hot state in which it once was. Altogether then, you see, the moon must be a very strange place, with its thousands of dead volcanoes, and its long mountain ranges, and these great gulfs seaming its surface. Some of the mountainous parts of the world are wild enough, but we have nothing here that is anything like so wild and rugged as some parts of the moon.

THE EARTH ONE OF A FAMILY

It is rather pleasant to think of the moon as our moon, belonging to us and circling round us. In the same way we are tempted to think of the sun as our sun, moving in the heavens to give us light and heat. But here our pride has a fall. While the sun is our sun because we depend on him and live by him, it would be truer to say that we are one of his little worlds, for the sun is the head of a family of which our earth is one of the tiniest parts. If we study the sun by itself or only as it has to do with our own world, we get no idea of what a mighty force it is. Only when we think of our earth as one of a family of greater worlds, all turning round the sun as we do, and of the sun as the head and ruler of all these revolving worlds, do we begin to have the faintest idea of the sun's importance and power. This marvelous sun family to which we belong is called the "sun system," or from the Latin word for sun, *sol*, the "solar system."

Courtesy Harvard College Observatory

THE MOON'S SURFACE, AS THE TELESCOPE SHOWS IT

WHAT A SPECTATOR ON THE SUN MIGHT HAVE SEEN BETWEEN TEN O'CLOCK IN THE MORNING OF APRIL 17, 1912, AND ONE O'CLOCK IN THE AFTERNOON OF THAT DAY: THE MOON PASSING THE EARTH AND DESCRIBING A COURSE DUE TO ITS OWN ROTATION AND THAT OF THE EARTH

EARTH'S BROTHERS AND SISTERS IN THE SUN FAMILY

When men began to look at the heavens, they found that most of the stars seemed to keep in the same groups and not to change their places. There were the Great Dipper, and the Small Dipper, and a great many other groups which men named from their shape, which kept in the same relation to each other, and have kept so for hundreds and thousands of years. But then there were other stars which seemed to be always moving about. Also they shone very brightly indeed — two or three in particular that are often brighter than any other stars in the sky, and that shine with a much steadier light than the others. You know how the stars are always twinkling and flashing; but, if you watch these two or three, you will see that they scarcely ever twinkle, but keep steadily shining.

These moving stars are really worlds, like our own world, and not stars at all; and they are not nearly as big as even the dimmest and finest of the other stars, no matter how brightly they shine. They look so bright simply because they are much nearer to us than any of the true stars. The name that has been given to them is the "planets," or "wanderers," because they appear to wander among the stars; and they belong to the same family to which our own world belongs, — this solar system. The sun is the center round which all these worlds travel. They move continually round him in rings which are not exactly, but very nearly, circles. Some of these worlds are smaller than our own, and some are very much bigger; but none is anything like so big as the sun, which keeps them all moving round him, and gives them light and heat.

THE PLANETS, OR "WANDERERS"

Of all the objects in the heavens, the planets are the most interesting to us. Though removed from us by millions of miles, they are still nearer than any of the other star-worlds. Then, too, they are more like us than any other world, for, after all, the earth is only a planet, not a very large one nor a very small one. Counting our earth as one, there are eight of these worlds in our solar system, and also a number of tiny planets, called "asteroids." These likewise go round the sun, but are very much smaller than any of the first eight, and stand in a class by themselves, so that when the planets are mentioned it is generally the eight large, well-known planets which are referred to. These make up the solar system, and in it the only thing that shines by its own light is the sun; all the rest, the planets and their moons, shine only because the rays of light from the sun strike on their surfaces and are reflected off again. Our earth shines like that, and from the nearer planets must appear as a brilliant star.

This is the chief distinction between stars and planets. Stars are suns — mighty globes of glowing flame. The planets simply receive the light of the sun, and shine with a brightness not their own.

A lamp shines by its own light; but a look-

ing-glass, set in the sun's rays and flashing beams in all directions, shines by reflected light. In a dark room it would be dark. If there were no sun to shine upon Mars or Venus we should see no brightness in them. The moon is like the planets in this. She has only borrowed light to give, and none of her own.

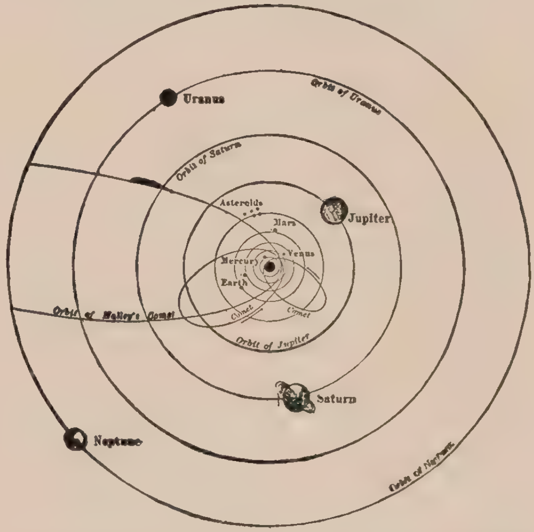
Any one of the planets removed to the distance of the nearest fixed star would be invisible to us. Reflected light will not shine nearly so far as the direct light of a burning body. There may be thousands or millions of planets circling round the stars — those great and distant suns — just as our brother planets circle round our sun. But it is impossible for us to see them. The little solar system is separated by distances beyond the realm of thought from the rest of the universe. Vast as are the intervals between ourselves and our planetary neighbors, they are as nothing to the space that separates us from the nearest of the steady-shining fixed stars. Why, removed as far from us as the stars, the sun himself would have sunk to a point of light; and as for the planets, the largest of them, Jupiter, could not possibly be seen. Thus, when we look at those stars across the great gulf of space, we know that though we see them they cannot see us, and that to them our sun must seem only a star.

OUR PLACE IN THE SOLAR SYSTEM

The orbits of the planets, as their paths round the sun are called, lie like great circles one outside another at various distances, and do not touch or cut each other. Where do you suppose our own place to be? Will it be the nearest to the sun or the farthest away from him? As a matter of fact, it is neither; we come third in order from the sun, for two smaller planets, one very small and the other nearly as large as the earth, circle round and round the sun in orbits lying inside ours.

If the pathway or orbit of our earth were pictured by a hoop laid upon the table, with a ball in the center for the sun, then those two planets would have two smaller hoops of different sizes *within* ours; and the rest would have larger hoops of different sizes *outside* ours.

A round hoop would not make a perfect picture of an orbit. For the yearly pathway of our earth is not in shape perfectly round, but slightly oval, more like the shape of an egg than that of a ball, and the sun is not exactly in the center, but a little to one side of the center. This is more or less the case with the orbits of all the planets.



OUR SOLAR SYSTEM AND ITS ORBITS, WITH SOME COMET COURSES ALSO

But the laying of the hoops upon the table would give no bad idea of the way in which the orbits really lie in the heavens. The orbits of all the chief planets do not slope and slant round the sun in all manner of directions. They are placed almost in the same *plane*, as it is called, or, as we might say, in the same *flat*. In these orbits the planets all travel round in the same direction. One may overtake a second on a neighboring orbit, and get ahead of him, but one planet never goes back to meet another.

WHAT BINDS THE FAMILY TOGETHER

Before we talk about these different brothers and sisters of the earth, and their sizes and distances from the sun, let us stop to ask ourselves what it is that keeps this sky-family together. It is the power of the great head of the family, the sun. It has been said that if the comparison were not offensive to the sun-god, we might

say that he is like a spider at the center of his web. From the center of his web to his nearest planet is thirty-six million miles; to the farthest, about twenty-eight hundred million miles. But he holds them all in this invisible web by the power of his pull. This mysterious power which the sun has, and the earth has too in a smaller way, is called "gravitation."

WHAT IS GRAVITATION?

The force of gravitation is well known to us in what we call "weight."

What causes an apple to fall to the ground when it drops from the branch? Why should it not fall up instead of down? Because, of course, it is heavy, or has weight. But what is weight?

Simply this: that the earth draws or drags everything downward towards herself, by the power of attraction. All substances, great or small, light or heavy, are made up of particles. Each of these particles attracts or draws all the other particles towards itself; and the nearer they are together, the more strongly they pull one another.

A ball of iron is heavier than a wooden ball of the same size. Therefore we say that it weighs more, or that it has greater "mass." Weight and mass are not the same, as a ball of iron weighing sixty pounds on the earth would weigh only ten pounds on the moon, if spring balances were used to do the weighing. This is owing to the difference in mass of the earth and the moon.

Now as the earth is immeasurably heavier than anything that is on it, it pulls everything towards itself with such force that the little pulls of other things upon each other are not noticed. The earth draws us all towards it. It is holding us down to it every minute of the day. If we want to move we have to exert another force in order to overcome this attraction of the earth, so we exert our own muscles and lift first one foot and then the other away from the earth, and the effort we make in doing this tires us. All the while you are walking or running you are exercising force to lift your feet away from the ground. The pull of the earth is called "gravitation."

THE SUN'S PULL

Now precisely as an apple falling from a tree, and a stone dropping from a cliff, are dragged downward to the earth, just so our earth and all the planets are dragged towards the sun and towards each other. The law of the earth's attraction of all objects on its surface to itself was dimly suspected a very long time ago; but it was Sir Isaac Newton who first discovered that this same law was to be found working among the members of the whole solar system. The sun attracts or draws towards it the earth, and the earth attracts the sun. But the enormous size of the sun compared with our earth — like a great nine-foot globe beside a tiny one-inch ball — makes our power of attraction to be quite lost sight of in his, which is so much greater.

NEWTON AND THE APPLE

It was in the year 1666 that Newton, a young man in his home in England, first hit on the idea of gravitation as it affects not only our earth but the solar system. The story goes that while Newton was sitting in his garden he saw an apple fall to the ground. He knew why the apple fell; it was heavy, it was pulled by the earth. He was led to ask if the same force did not keep the moon in its monthly path round the earth, and prevent it from flying off into space. After twenty years he was able to prove by his studies that this was true.

The problem of the ancients was, How could the earth hang in space? It could not, they said; therefore it must rest on something, the shoulders of an Atlas or the waters of an ocean. It could, said Newton, by the power of gravitation — that marvelous, invisible bond everywhere present, working through all space, which keeps the planets under the control of the sun, making order out of chaos, and a solar system out of a group of rushing worlds.

So Copernicus showed us our earth's position in the solar system, and Newton showed us why and how we could hold it.

THE OTHER FORCE

But if the force of gravitation is so strong, someone may ask, why does not the sun pull

all the planets right to himself and burn them up in his tremendous heat? That is a very good question, and takes us back to the beginning of the world. If the planets were at rest, if they were not moving at all, they would have been drawn right into the sun by the force of gravitation. But they are not at rest. They are going at a tremendous speed. Even this earth of ours is rushing through space at a rate of nineteen miles a second, and it is only because, through gravitation, the garment of air round it moves just as fast, that we do not know anything about this fearful rate at which we are dashing along. All the planets are moving, some three or four miles a second, and others even faster than we. Now it is one of the laws of the universe, which we cannot explain, but which we know, that any object which is moving will keep moving in a straight line unless something interferes with it.

THE VARYING FORCE OF GRAVITY ON DIFFERENT PLANETS

The bigger and heavier a world, the stronger the pull it exerts. In the center is the normal jump of an athlete on Earth; to the right his jump on the Moon, where the same amount of effort would carry him six times as high; to the left his jump on Jupiter, carrying him not quite half as high.

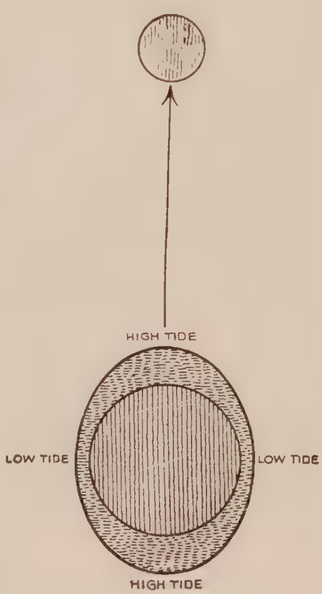
In the beginning God made the world, and set it off by a first impulse. We do not know how it was done; we only know that, at some remote age, this world, probably very different from what it is now, together with the other planets, was sent spinning off into space on its age-long journey. But the first force which started the worlds into space followed this law of motion and gave them the impulse to go on in a straight line. So when the sun pulled, the result was a movement between the two: the planets did not continue to move in a straight line, neither did they fall on to the sun, but they went on a course between the two — that is, a circle — for the sun never let them get right away from him, but compelled them to move in circles round him.

The sun's pull and this other force, both of which have been acting these thousands of years, explain the solar system of which we are a part.

WHY WE HAVE TIDES

From gravitation to tides seems a big jump, but it isn't a jump at all, for tides are due to the pull of the moon on the earth. Besides giving us light at night, this is one of the moon's great services to us. Without the rising of the sea twice in every day and night our coasts would become foul and unwholesome, for all the dead fish and rotting stuff lying on the beach would poison the air. The sea tides scour our coasts day by day with never-ceasing energy, and they send a great breath of freshness up our large rivers to delight many people far inland. The moon does most of this work, though she is a little helped by the sun. The reason of this is that the moon is so near to the earth that, though her pull is not very strong, it is very strongly felt. She cannot move any parts of the earth, as it is so solid; but when it comes to the water she can and does work on that, so that the water rises up in answer to her pull, and as the earth turns round the raised-up water lags behind, reaching backward towards

the moon, and is drawn up on the beach, and makes high tide. But it is stopped there, and meanwhile, by reason of the earth's movement, the moon is left far behind, and pulls the water to itself farther on, when the first high tide relapses and falls down again. At length the moon gets round to quite the opposite side of the earth to that where she began, and there she makes a high tide too; but as she draws the water to herself she draws also the solid earth beneath the water to her in some degree, and so pulls it away from the place where the first high tide occurred, leaving the water there deeper than before, and so causing a secondary high tide.



TIDES, SHOWING THE MOON'S VARYING PULL

The sun has some influence on the tides too, and when moon and sun are in the same line, as at full and new moon, then the tides are highest, and are called spring tides; but when sun and moon pull in different directions, as when it is half-moon, then the tides are lowest.

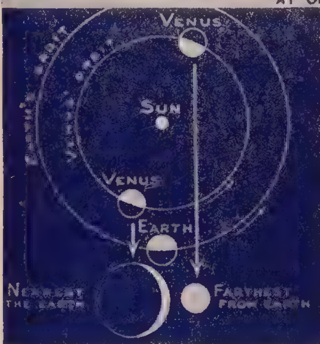
THE EIGHT PLANETS

The planets, as they are held in their paths by the sun, are divided into two groups: the inner planets, Mercury, Venus, Earth, and Mars, and the outer planets, Jupiter, Saturn, Uranus, and Neptune. These two groups are separated by a wide belt of the smaller planets, seven hundred or more little worlds, of which the largest is hardly five hundred miles in diameter. The distances of these planets from the sun are so great that we cannot grasp them — not only thousands but millions and hundreds of millions of miles; but there is one curious fact about them. Within the inner circle, and again within the outer, each planet after the first is, very roughly, about twice as far from the sun as the one inside it. Of the inner group, Earth is the largest, Mercury and Mars are much smaller, Venus nearly equals the Earth in size. The outer four are giants compared with Earth. Uranus and Neptune measure over 30,000 miles through, while our diameter is, you remember, only 8,000 miles; and Jupiter and Saturn are giants compared with them, having diameters of 89,000 and 76,000 miles. These are figures too big for us to think about even in trying to imagine worlds, but we can get from the picture a little idea what a tiny dot our great earth is when it is compared to these huge worlds. All this helps us, too, to understand how wonderful the sun is, for all these huge planets are small compared with the sun. If the sun were a hollow ball and all the eight planets were tipped into it, they would fill only $\frac{1}{560}$ of its space.

PLANET RACERS

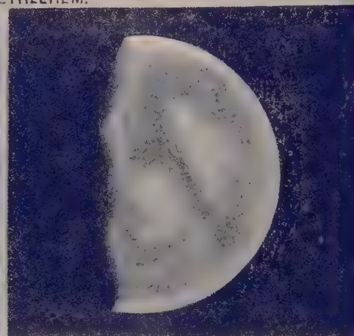
Another interesting thing about the planets is their speed. This grows less as we go out in the circle. Mercury is so near the sun, and is therefore so strongly pulled by it, that it has to travel very fast, or it would be pulled into it and be burned up. It travels along at a rate of thirty miles a second. Venus goes at twenty-two miles a second, Earth at nineteen, and Mars at fifteen. But Jupiter and the other outer planets are far enough away from the sun to go along at a much more leisurely rate, Jupiter going at eight miles a second, Saturn at six, Uranus at four, and Neptune at only three. Let us see if we can get a clearer idea how fast that is. Chicago is a thousand miles from New York. At the rate Mercury travels, or thirty miles a second, it would take a train only about thirty-three seconds to go from New York to Chicago. At the rate of our Earth, an aeroplane would fly to Chicago in a minute, with several seconds to alight. Our Earth is traveling nineteen miles a second, or 1,140 miles a minute, or 68,400 miles an hour. At that rate one could go around our world from New York to New York again in twenty-

THE CELESTIAL BEACON; THE PLANET THAT HANGS ON THE SHORES OF EVE AND MORN LIKE A JEWEL; AT ONE TIME BELIEVED TO BE THE STAR OF BETHLEHEM.

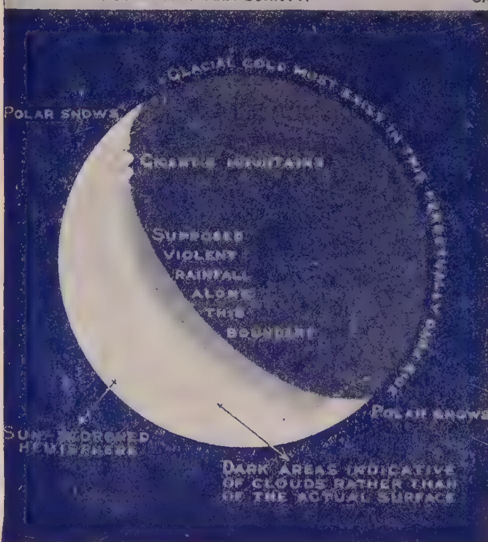


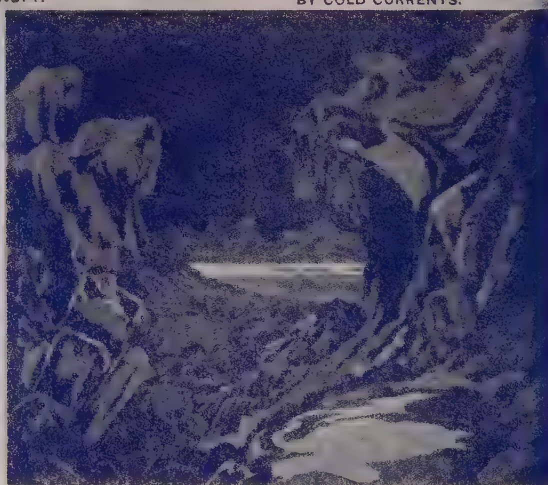
WHEN NEAREST THE EARTH VENUS EXHIBITS ITS INVISIBLE HALF TO US; HENCE OUR KNOWLEDGE OF ITS SURFACE IS COMPARATIVELY SCANTY.

THE VENUSIAN ALPS (MARKED A) ON MAY 15th, 1900. ESTIMATED AT 40 MILES IN HEIGHT, THEY PROJECT ABOVE THE CLOUD CANOPY.



THE BOUNDARY BETWEEN DAY AND NIGHT IS FREQUENTLY DISTORTED. SUCH A PHENOMENON IS EXPLAINED IN PART BY AN UPRUSH OF HEATED AIR, AND BY ATMOSPHERIC COMPRESSION INFLUENCED BY COLD CURRENTS.





A FAINT CONCEPTION OF THE VENUSIAN GLACIAL CONDITIONS WHICH MUST OBTAIN EVEN AT THE EQUATOR IN THE FRIGID SUNLESS HEMISPHERE.

VENUS, WHERE CONDITIONS ARE UTTERLY UNLIKE OURS

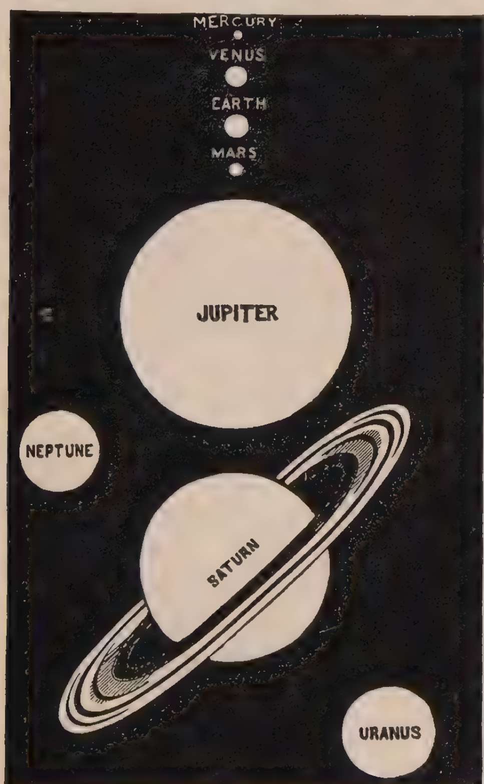
Since "the beginning of things" Venus has had one hemisphere turned perpetually towards the Sun. This sunlit half must be terribly scorched; the night side perpetually ice-coated.

five minutes, with something to spare for delay.

This speed decides the length of their years, for our year is the length of time which it takes us to travel round the sun. Mercury rushes along so fast that it gets round in 88 days, and so has four years to our one on Earth; Venus has 225 days in its year; Earth 365, and Mars 687, while Uranus only gets round the sun once in 84 of our years, and it actually takes Neptune 164¾ of our years to pace out its remote and immense course.

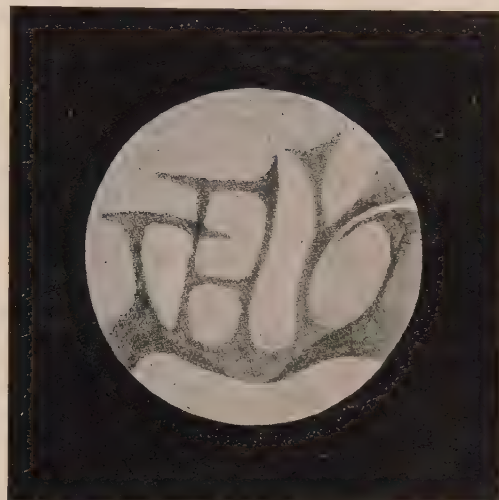
PLANETS WE CAN SEE

Of the planets you will soon learn to pick out one or two, and will recognize them even if they do change their places. For instance, Venus is at times very conspicuous, shining as an evening star in the west after the sun goes down, or as a morning star before he gets up. She is never very far from the sun. Jupiter is the only other planet that compares with Venus in brilliancy, and he shines most beautifully. He is, of course, much farther away from us than Venus, but so much larger that he rivals her in brightness. Saturn can be quite easily seen as a conspicuous object, too, if you know where to look for him, and Mars is sometimes very bright with a reddish glow. The others you would not be able to distinguish.



THE RELATIVE SIZES OF THE PLANETS

To compare the sizes, remember that Mercury is 3,000 miles in diameter, the Earth 8,000 miles, Saturn 76,000 miles, and Jupiter 89,000 miles.



MERCURY, THE MESSENGER

MERCURY AND VENUS

Mercury is so small and keeps so near to the sun that he is very hard to see from Earth. Indeed, from some parts of the globe he is almost never seen. He gets his name from his great speed, for Mercury was in the Greek mythology the messenger of the gods, darting swiftly along on their errands. He is not such a tiny messenger, however, for he is a good deal larger than our moon.

Every one must have noticed Venus, our beautiful evening star, which shines like a little silver lamp close to the sun at sunset. There is no star in all the sky that shines so brightly as Venus does when she is at her brightest. It is a curious fact that some planets shine much more brightly than others,

without regard to their size — that is to say, the surface on which the sun's rays strike is of greater reflecting power in some than in others. One of the brightest things in Nature that we can imagine is a bank of snow in sunlight;

VENUS, THE EVENING STAR

it is so dazzling that we have to look away or wink hard at the sight; and the reflecting power of the surface of Venus is as dazzling as if she were made of snow. This is probably because the light strikes on the upper surface of the clouds which surround her. In great contrast to this is the surface of Mercury, which reflects as dully as a mass of lead. Our own moon, although appearing quite bright when at her best, has not a high reflecting power, as compared with a brilliant planet like Venus.

THE "SILVER LINING"

Why is Venus so bright? Probably because she is always wrapped in thick clouds. You know the old proverb, "Every cloud has a silver lining"; but did you ever think what it means? It means that those days when our sky is all covered with dark clouds and we have to spend our time indoors because of the rain are the days when our world is shining far more brightly to the other worlds than on our bright, cloudless days. For all the planets, and our own world like the rest, shine by the sunlight which they throw back from their surfaces. And when we have dull, cloudy days, the light that does n't get through the clouds is nearly all thrown back from the outer side of them, so that they shine to the other worlds almost as white as newly fallen snow. If the whole world were wrapped up in a great dark cloud, it would look from the outside just like a huge ball of snow. When we look at Venus we see simply the "silver lining" of her clouds.

So far as size goes, you might call Venus the twin sister of Earth. She is only a little smaller than our world, and she comes nearer to us than any of the other worlds of our family. As she goes round the sun in a circle inside our earth's orbit, she appears first on one side of the sun and then on the other, and so is seen as an evening or as a morning star in turn. And because she is between us and the sun she shows what astronomers call "phases" — that is to say, she changes like the moon, and is sometimes round and full, sometimes like a half-moon, and sometimes just a thin slip of light, like the new moon. There are few things in the heavens so beautiful as Venus when she appears like a crescent moon.

MARS, THE RED PLANET

Sometimes you will see in the sky a star which is distinctly reddish in color. This is the planet Mars, named because of his blood-color for the Roman war-god Mars. "Once in every fifteen years," says a famous astronomer, "a startling visitor makes his appearance upon our midnight skies — a great red star that rises at sunset through the haze above the eastern horizon, and then, mounting higher with the deepening night, blazes forth with a splendor that outshines Sirius and rivals the giant Jupiter himself. Startling for its size, the stranger looks the more fateful for being a fiery red. Small wonder that by many folk it is taken as an evil sign." Mars has always frightened ignorant people. It seemed hardly possible to them that so red and fiery a light should appear without being a sign that war and trouble were to follow on earth.

Mars is the most interesting to us of all the planets because he is most like us. Because he comes nearer to us and turns himself when he is near so that he can be well seen, we know more of the surface of Mars than of any other body, except our moon, in the entire universe.

DO PEOPLE LIVE ON MARS?

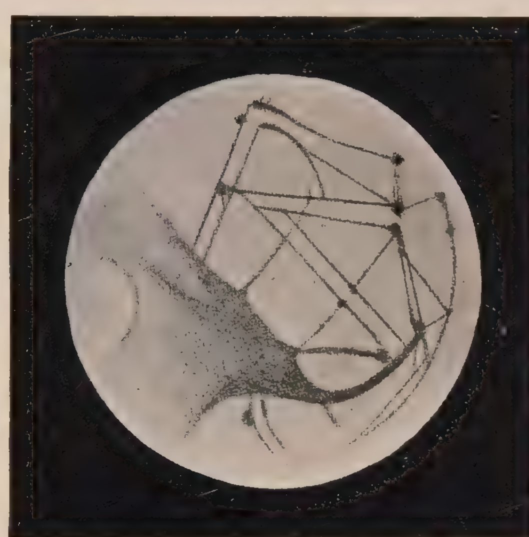
Mars has days and nights as we do. Its day is only half an hour longer than ours. While Mercury and Venus turn themselves about so slowly in their path round the sun that it takes each the whole length of one of its own years to turn completely round, Mars spins round in a day much as we do; so instead of one face being towards the sun for nearly half its year and the other turned away, as in the case of Mercury and Venus, all parts of Mars have their turn of the sun's light and heat once in a day and night like ours. Then Mars, too, has a north and a south pole, and its tip towards the sun is so much like ours that its seasons must be very like those we have. Also, Mars has an atmosphere, a blanket of air surrounding it. According to studies recently made, this atmosphere may be a very dense one,—possibly one hundred miles deep by the surmises of one careful observer. In 1877 it was found out that Mars has two moons, traveling round it. One travels so fast that it goes round Mars three times each day.

Because Mars is so like us in all these ways, there has been, especially in the last few years, a great deal of discussion as to whether there could be people, not like us, but some sort of people, living on Mars. One man in particular, the late Professor Percival Lowell, thought this was possible if not even probable. Most astronomers think it unlikely. But it is an interesting idea to think about, and makes everyone want to find out all he can about Mars.

MARS THROUGH A TELESCOPE

When you see him in the telescope, the bright red star that you saw with the naked eye expands into a broad red globe of a fiery orange color. At the poles this globe is capped with patches of brilliant white, which stand out very brightly on the reddish ground that surrounds them; and the red surface is marked all over with patches and streaks of a darker color which are generally of a sort of greenish-blue.

Look at the map of Mars, in which the surface appears to be cut up into land and water, continents and oceans. The men who first observed Mars with accuracy saw that some parts were of a reddish color and others greenish, and arguing from our own world, they called the greenish parts seas and the reddish land. Maps were made in which these seas were named after some of the famous astronomers of our world. For a long while no one doubted that we actually looked on a world like our own, more especially as there was supposed to be a covering of atmosphere. The so-called land and water were much more cut up and mixed together than ours, it is true. The red color of the part they named land puzzled astronomers a good deal, for our land seen at the same distance would not appear so red, and they came at last to the conclusion that vegetation on Mars must be red instead of green! But after a while another disturbing fact turned up to upset their theories, and that was that they thought they saw "canals," or what they called canals, on Mars.



MARS AND HIS CANALS

THE CANALS OF MARS

A great Italian observer, about thirty-five years ago, startled everybody by saying that he had discovered that the whole of the Red Planet was streaked over with a network of long, thin, dark lines. Some people could not see these lines at all, but many could, after they had once been found; and ever since then more and more have been discovered, until the map of Mars is quite covered with them.

These straight lines are called "the canals of Mars." "Canals" is not a very good name for them, because, when we talk of a canal, we mean a great ditch, dug by human beings between two seas or two rivers, and filled with water so as to make a waterway; and no one really knows if the canals of Mars are like that, or, indeed, what they are at all. If they are cuts in the surface of the planet like canals, they are of great width and depth. The narrowest of them would measure 50 miles in width, and the widest nearly 200 miles, while some of them would be 3000 miles long.

Most interesting in its bearing on the question of the possibility of vegetation and of life on the planet is the study of the temperatures on the planet, which has been carried on with great care and thoroughness at two observatories. These would seem to indicate that near the middle of the Martian day the temperature at the equator, where the most benefit from the sun's rays is being obtained, ranges from 45 to 65 degrees Fahrenheit. These results run high enough above the freezing point to allow for some sort of vegetation. Near the polar caps, however, the temperatures run extremely low. These polar caps may, according to the same set of observations, be clouds or banks of heavy haze, occasioned in part by the very dense atmosphere surrounding the planet.

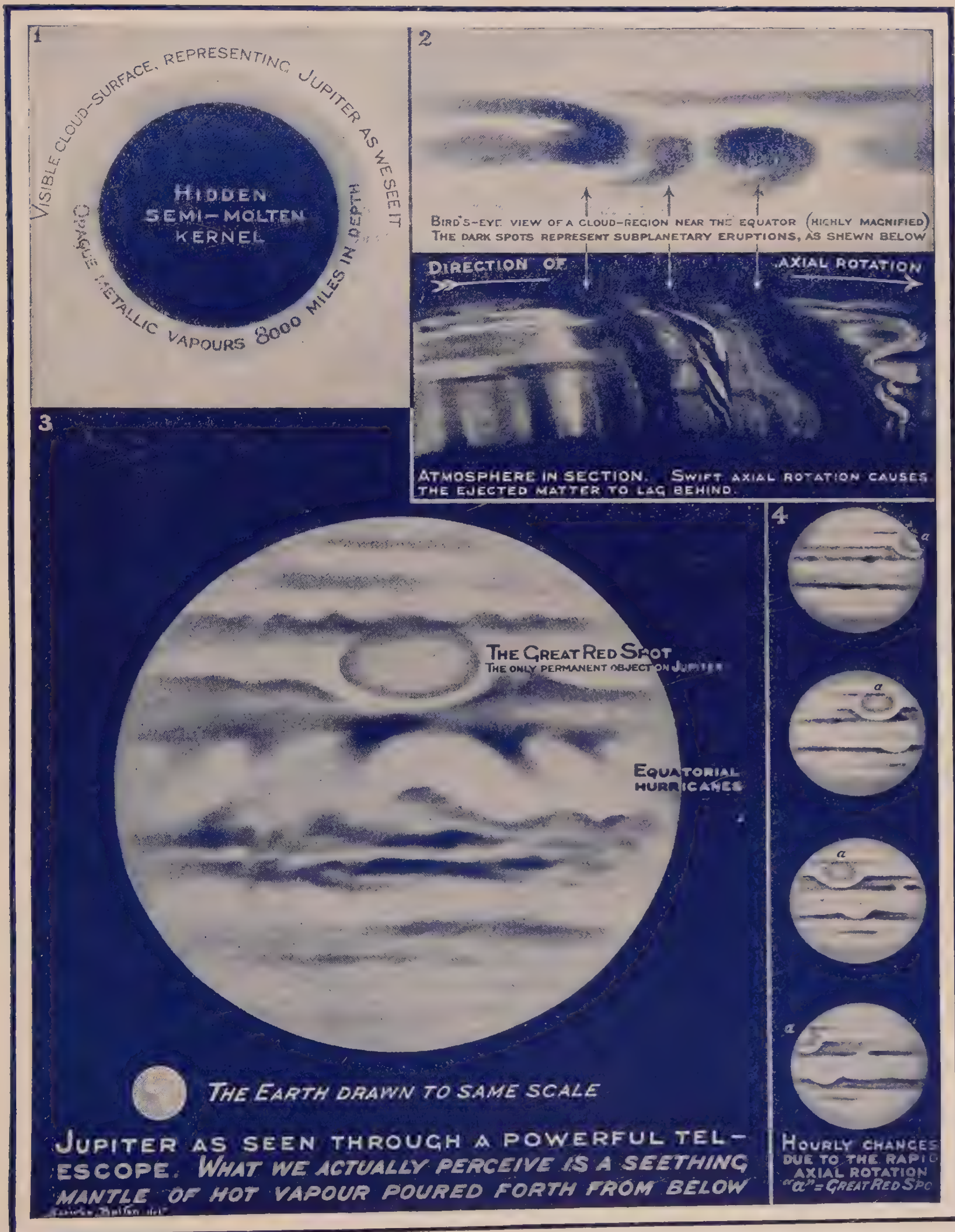
The idea of possible vegetation is supported by one fact. As soon as the white cap at the pole of Mars begins to grow smaller, as if it were melting like snow, the dark lines of the canals nearest to it begin to grow darker. A recent set of photographs seems to indicate conclusively that the dark regions grow larger and deeper in hue as the polar caps wane and the so-called spring season on Mars advances. In the same way the dark markings on the opposite hemisphere grow less conspicuous, seeming to fade away as autumn is presumably changing into winter. The very fact that there are these seasonal changes seems to imply some sort of vegetation. If there can be one kind of life, other types are possible.

You must remember that this is more or less fancy, for we really know very little about these strange appearances. Many skilled observers with exceptionally good telescopes and under favorable conditions are unable to see any canals at all. Every two years, as Mars sweeps round outside our world, he comes into a position where we can see him well. Whenever that happens, astronomers all over the world watch him eagerly, and try to find out more about him; and we may hope that, since so much has been learned already, we may before long come to understand yet more about this wonderful little world.

JUPITER, THE GIANT PLANET

Outside the path of Mars lies that of the planet Jupiter, or the "Giant planet." Jupiter is the biggest planet of our sun family, and is more than thirteen hundred times as large as our earth. Perhaps the most interesting thing about Jupiter is his moons. While the earth has only one moon, and Mars two, Jupiter has eight. It would be indeed a beautiful sight to see eight moons in the sky at one time, but Jupiter is even farther away from us than Mars, and four of his moons are very tiny and thus difficult to see. The other four are large, however, and can be well seen with even a small telescope. Just as the moon travels round the earth, so Jupiter's moons travel round him, and through a telescope we can see them slowly moving.

Galileo, who lived in Italy in the sixteenth and seventeenth centuries, was the first man to turn a telescope to the heavens. He turned it one night to Jupiter, and there he saw the wonderful sight of the moons traveling round the great planet. Now Galileo had been trying to make people believe that the earth was not the center of all things, but that it and other worlds traveled round the sun; but although it was sixty-five years since Copernicus had put forth this theory, people had not come to believe it.



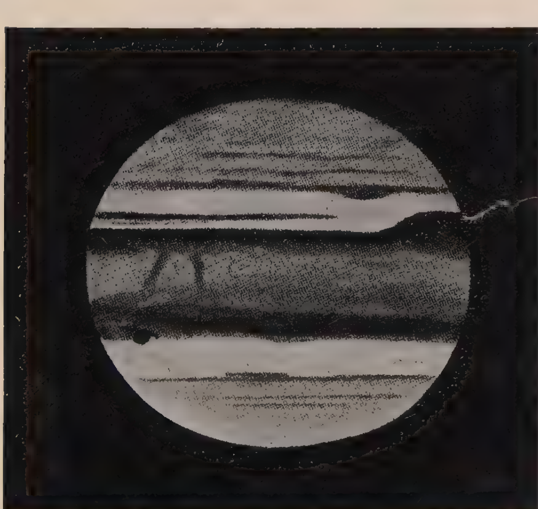
JUPITER, THE GIANT PLANET

The Atmosphere of Jupiter, as we see in (1), is opaque, 8000 miles deep; the vapor rushing from the center makes fearful tempests, (2) increased by the swift rotation. Only the Red Spot in (3) is stationary, as we see in its rotation in (4).

When Galileo began to study the heavens with a telescope and saw Jupiter and his moons, he said at once, "This is the way the earth travels round the sun." So he told the people about this wonderful sight he had seen. They would not believe him, so he asked them to come and look for themselves. They looked and saw what he had seen, and then they said that Galileo had bewitched the telescope or their eyes. At last, however, other learned men took up the subject, and the sight of Jupiter with his moons traveling round him helped to prove that the earth and other worlds were really traveling round the sun. Later in life Galileo was cast into prison and made to deny that he believed the earth traveled round the sun and compelled to promise not to teach such a doctrine.

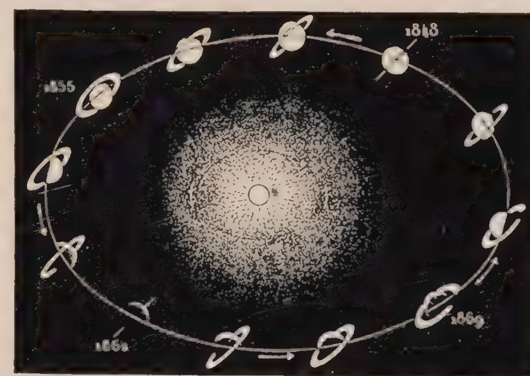
THE WORLD WITH THE GOLDEN RINGS

When Galileo turned his telescope on Saturn, which is the next world beyond Jupiter, he could scarcely believe his eyes, for instead of



JUPITER, THE LORDLY PLANET

one globe he seemed to see three. He never found out what made this curious effect, but we know that it was what we call the rings of Saturn. Saturn with his rings is one of the most beautiful objects that we can ever see in the heavens. Round and round the bright central globe circle a beautiful series of rings, dark and light, such as you see in the picture. It was a complete mystery to the people of the Middle Ages how a planet could be surrounded by rings which had no means of support, for they do not touch the planet at any spot. It has been lately shown, however, that Sat-



PHASES OF SATURN'S RINGS

urn's rings are made up of multitudes of little moons or planets, each traveling in its own path around the planet, just as the larger moons of Jupiter, or its own ten large moons, do.

There are three of these rings, lying one within the other, and separated by a fine line from each other. The middle one is much the broadest — probably about ten thousand miles in width — and the inner one, which is also the darkest, was not discovered until the year 1850. As the planet swings in his orbit he tilts himself differently at different times, and so at one time we are looking at the rings almost from above, at another time we appear to be looking at them when they have turned a little farther upwards, and again we see them exactly edgewise. Then even in the largest telescope they are only like a streak of light, and this shows that they cannot be more than fifty or sixty miles in thickness. The one which is nearest to Saturn's surface does not approach him within ten thousand miles.

TWO LONELY WORLDS

All the worlds that we have now read about were known to star-gazers as far back as the time when people began to know anything

about the world; but no one ever suspected that there were any more worlds in the sun's family until the night of March 13, 1781. At that time there lived in England a Hanoverian musician named William Herschel, who was organist of the Octagon Chapel at Bath. He was very fond of astronomy, and when his musical work was done, he used to come home and get out his home-made telescope and scan the starry sky. On this night of March 13, as he was looking at the stars, his attention was caught by one small star which seemed a little different from the others.

This proved to be the planet, named by him Uranus, for the father of Saturn, which had been

SATURN AS THE PLANET MIGHT APPEAR FROM ONE OF HIS MOONS

observed no less than nineteen times before, but never until he studied it had been recognized as a planet. This was in 1781. Something in the movements of Uranus made astronomers think that there was another planet outside it, pulling it out of its natural path. Leverrier, a French astronomer, computed where such a planet should be, and in 1846 wrote Galle, a German astronomer, to direct his telescope to a certain part of the sky, and he would find a new planet. Within half an hour after beginning to look, Galle found the planet called Neptune.

Uranus has been found to have four moons traveling round him, and Neptune only one. There he goes, this most distant member of our family — a lonely sentinel, keeping watch and ward over the frontiers of the solar system, with only his one moon for company, and traveling his long round in what would seem to us almost utter darkness, for the sun can give him only about $\frac{1}{900}$ of the light it gives us.

STRANGE SIGHTS IN THE HEAVENS

SHADOWS OF WORLDS

SHADOWS make all sorts of queer effects. You know yourself how you can make animal shadows on the wall from your fingers, and how, as you walk along, your shadow will grow tall and then short again and take all kinds of strange shapes. If you saw some of these shadows without knowing what made them you would think they were very queer people and animals living on the earth, and you would not know how to explain them at all. That is just what happened in the old days when there were eclipses. *Eclipse* comes from the Greek word *to fail*. When there is an eclipse, the light fails. Sometimes it fails because the moon gets between the earth and the sun, and the sun is almost wholly covered. We call that a sun or solar eclipse. More often the earth gets between the sun and moon, so that it throws its shadow on the moon, and that is an eclipse of the moon. Our astronomers can predict from what they know of the movement of the heavenly bodies just when these eclipses are going to happen; they tell us beforehand; and we, because we know what is coming, are very much interested and not at all frightened when the sun or moon is darkened for a time, and all kinds of strange light effects are produced in the sky. But the early peoples were very much frightened when these strange things happened, and they made up wonder stories to explain how such marvelous and dreadful events could take place.

It is no wonder that people are frightened by the solar eclipses, for they are truly awe-inspiring. All nature is affected by them; the flowers close, the birds go to rest, animals in woods and fields seek refuge. The cattle in the fields grow restless during a long eclipse, and dogs set up long howls. A pale, mysterious light makes everything look ghastly. The sun looks like a black face, and the stars shine out as in the night-time. Only when the first sunbeam escapes from the edge of the moon does the mystery vanish, and we breathe freely again.

Early and uncivilized peoples believed that a mighty dragon was trying to swallow the sun. If he succeeded, the end of the world would

THE MOST WONDERFUL CREATION IN THE VISIBLE UNIVERSE

Saturn and his rings of flying myriads of small particles, attended by his eight largest satellites. This beautiful planet is composed of such light material that it would float like oak on water. Saturn is nine times greater in diameter than the Earth. The rings are composed of nothing more than a flight of myriads of small particles round their primary, the inner ones revolving once in 5 hours 50 minutes, the outer ones in 10 hours.

[illegible]

come. So they made every effort, in the midst of their own terror, to try to frighten him away. To this day vast numbers of Chinese run out into the street at the first sign of an eclipse — of which for hundreds of years they have been carefully warned by astronomers — and set up a terrific din with drums, whistles, trumpets, sticks, and yells, to scare away the monster, and force him to give back the victim which has just disappeared between his huge jaws.

STORIES OF ECLIPSES

Though they did not understand what made them, astronomers learned very early in star-study to reckon on the times of eclipses and to let people know when they were going to happen. This was part of the business of the court astronomers in China, more than four thousand years ago, and there is a story in a very old Chinese book telling about two astronomers, named Hi and Ho, who lived more than two thousand years before Christ. It was their duty to keep track of the movements of the stars and inform the people when events like these were going to happen. But they lived merrily and well at the court, and forgot the duties of their office, giving no heed to the course of the stars and thereby getting the whole court into a confusion about the reckoning of time. All at once, as fate would have it, they were overtaken by an eclipse of the sun. No one had been warned, and there was the greatest terror throughout the whole of China. When the eclipse was over, and the terror had subsided, the two unlucky astronomers were brought before the emperor and beheaded.

HOW AN ECLIPSE MADE PEACE

Thales, one of the Seven Wise Men of Greece, who lived about six hundred years before Christ, found out how to predict eclipses.

Eclipses occur in cycles of about eighteen years; so that if we have a list of eclipses taking place for the last eighteen years, we can predict very nearly the same series for the next eighteen years. Thales probably used this scheme. Herodotus tells how the "Eclipse of Thales," as it is called, brought peace between the Lydians and the Medes, who had been fighting for some years without either gaining a decisive victory. "In the sixth year, on the occasion of an engagement, it happened that in the heat of battle day was

HOW THE SUN LOOKS IN A TOTAL ECLIPSE

The left-hand cut shows the rays of the sun's corona. The right-hand cut shows another form of the corona at a different eclipse.

suddenly turned into night. This change of day Thales, the Milesian, had foretold to the Ionians, fixing beforehand this year as the very period in which the change actually took place. The Lydians and Medes, seeing night succeeding in place of day, desisted from fight-

COLUMBUS AND THE MOON'S ECLIPSE

ing, and both showed a great anxiety to make peace." This peace was cemented by a marriage between the children of the rulers.

HOW COLUMBUS GOT HIS SUPPER

An eclipse aided Columbus on the island of Jamaica soon after he discovered America. The savages had taken him and his companions prisoners, and would give them no food. By his reckonings he knew that an eclipse of the moon was coming. He called the chiefs to him and told them that if they did not bring him and his companions food that very night he would take from them the light of the moon. At first they laughed at him; but when the dark shadow began to creep over the face of the moon they ran to him with all the food they could lay hands on, beseeching him to forgive them and to order the moon to shed its light again. This happened on the 1st of March, 1504, a date by which according to modern tables of eclipses there should have been an eclipse. So it helps us to check up the date.

SOLAR ECLIPSES

Eclipses of the sun take place when the moon comes in between the earth and the sun, thus cutting off more or less of the sunlight. Eclipses are of two kinds, — partial, where only part of the light of the sun or moon is cut off, and total, where all the light is cut off. Though we may hope to see many partial eclipses of the sun, it is not often that we can see total eclipses in this country, as they are more often only visible in countries nearer the equator. A total eclipse is a very beautiful sight, and astronomers will willingly travel to far-off parts of the earth in order to see one.

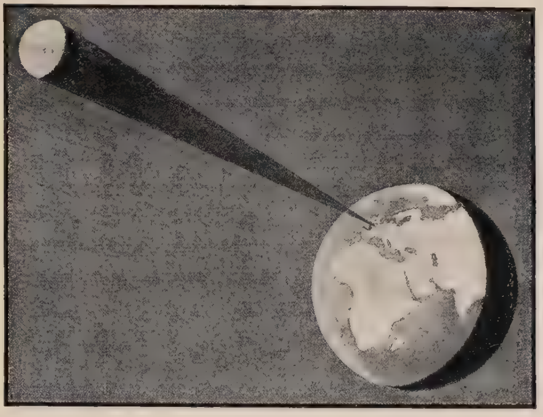
When a total eclipse of the sun takes place, the moon comes in exactly between the sun and the earth, cutting off all the sun's light for a few minutes. The time during which the sun is quite hidden is very short indeed — never quite eight minutes, and generally a good deal less. In that little time, however, a great deal can be seen.

When the moon comes between us and the bright globe of the sun, we see that a little bit of the sun is hidden, as if something were taking a bite out of the circle of light. Then gradually the dark "bite" grows bigger, and the daylight begins to fade. At last the moon gets right between us and the sun, and the last little streak of sunlight is blotted out. And then, in a moment, a most wonderful sight flashes before our eyes.

Now you see a big, round, dark globe where the sun was shining a little while ago. This globe looks as if it were made of black velvet — the globe of the moon which has just hidden the sun. But all around it there streams out on every side the most beautiful light. It is of a pearly white color, and shoots out here and there in great streams of light, some of them stretching for hundreds of thousands of miles across the sky. These beams grow fainter the farther they get from the sun, but close in to the edge they are all mingled together in a ring of dazzling brightness.

Nor is that all. The color of the glory changes at the very edge, and there is a perfect circle of brilliant crimson light running around the margin of the dark moon. This circle of light is very narrow but very bright; and here and there a great jet of crimson fire shoots out from the circle, and soars up for thousands, or even for hundreds of thousands, of miles, showing beautifully against the pearly background.

These things can be seen for only a very few minutes, for the moon is always moving onward. Soon the crimson flames on the one side begin to fade in the growing light, and those on the other side begin to get covered up by the advancing moon. Then, all of a sudden, there is a blinding flood of light as the edge of



WHEN THE MOON GETS BETWEEN THE SUN AND THE EARTH

the sun appears again from behind the moon, and the eclipse is over.

But you have seen the sun's crown, or *corona*, the beautiful halo of soft pearly light which is always round the sun, but is usually shut off from our view by the dazzling sunlight; and you have seen the flames of red fire, which will help you to believe that the sun is a great bubble within which the storms that make the sun spots are continually raging. These huge torrents of flame are rushing up from beneath the sun's surface. Every now and then there is a great outburst; but always red flames and crimson fire, 100,000 or 200,000 miles long, are being thrown out.

HOW OFTEN DO ECLIPSES COME?

The least possible number of eclipses in a year is *two*, both of the sun; the largest, *seven*, five solar and two moon (or lunar), or four solar and three lunar. The most usual number is four. In a year it is possible to have three lunar eclipses. This happened in 1852 and 1898, and again in 1917. With four solar eclipses, this made, in 1917, the highest number possible. Taking the whole earth into account, solar eclipses are more frequent than lunar. This is not so, however, at any given place. A solar eclipse can be seen from only a small part of the globe, while a lunar eclipse is visible over considerably more than half the earth. Solar eclipses that are total somewhere or other on the earth's surface are not very rare; but at any given place the case is very different. Since the track of a solar eclipse is a very narrow path over the earth's surface, averaging only sixty or seventy miles in width, we find that in the long run a total eclipse happens at any given place only once in about 360 years. During the nineteenth century seven shadow tracks crossed the United States, and there will be the same number in the twentieth. Total eclipses of the sun will be visible at some point in the United States in 1932, 1945, 1954, 1970, and 1979.

COMETS — PILGRIMS OF THE SKY

"Whene'er a comet doth appear,
Come mishap, want, sorrow, and fear;
And never hath a comet's sheen
Without great evil yet been seen.
These dire ill-fortunes do ensue
When a comet appears to view —
Fever, sickness, plague, and death,
Hard times, need, and hunger's scathe,
Great heat, drought, and barren Nature
War, murder, riots, fire, and slaughter,
Frost, cold, storm, and want of water;
For high folk death or humble lot;
Ill winds and earthquakes in many a spot.
Such mishaps everywhere arise
When comets course across the skies.
Repent we now in earnest prayer
God may ward off all harm and care."

That was the way people of the Middle Ages felt about these sky-pilgrims. Comets are very strange and beautiful sights. The word "comet" comes from a Latin word meaning "long-haired," and when seen at night a comet certainly does look like a long silvery hair, hanging against the dark sky. We talk of this hair as the comet's tail, for it stretches out from the bright head, which is the real comet, streaming far behind it across the sky, sometimes straight, and again twisting and curling as smoke from a chimney does on a windy day.

That is our idea of a comet. But there are comets of all sorts and sizes. Most of them can

never be seen with the naked eye at all. They are faint, little, fuzzy balls of light, which come drifting in towards the sun, sometimes shooting out a faint tail as they come near him, sometimes scarcely managing to make a tail at all, and never getting very bright. Then, when they have passed round the sun, they gradually drift away from him, losing most of the little light they had, and are soon lost to sight.

"BALLS OF FIRE"

A great comet is so big that it is difficult for us really to get an idea of its size. The January comet of 1910 had a tail that reached for more than 100,000,000 miles across the sky. If its head had touched the sun, its tail would have reached right across to our world, and the end would have waved 7,000,000 miles beyond us. And there have been comets with tails far longer than that.

What do we know about comets? We have learned, through the studies of astronomers, that they are not, as men of old thought them, "balls of fire hung in the sky by an angry God" to give sign of some coming misfortune. But what are these strange and mysterious visitors? Many of them, possibly all, are members of another family belonging to the sun. They start from the sun; they travel, each one on a path of its own, which is much more irregular than those of the planets; and that path, however far away it may go, leads them back to the sun. Comets which do this always make the journey in a fixed length of time, just as planets do. So astronomers now can tell when certain comets are due as certainly as you can tell from a time-table when your train is due. But the journeys of comets are often much longer than those of planets. They vary from three and a half to over two thousand years. So comets are very wonderful pilgrims indeed. The worlds that go round our sun are called "planets," or "wanderers"; but the name might be far more truly given to the comets, for they are the real wanderers of the heavens.

HALLEY'S COMET — THE COMET OF CONQUEST

The first comet actually found to be a regular visitor to the sun was Halley's Comet, which made such a stir in the spring of 1910. In the year 1682 a fine comet was seen, and Halley, a famous English astronomer, though he saw it only once, and not very well then, was much interested in it, for this reason: that, when calculating the paths of a number of comets, he found that either this one, or else one which followed exactly the same path, had appeared three times in the two hundred years before. Soon he became sure that it was the same comet which came back every seventy-six years, and ventured to prophesy that it would return in 1759, saying, "If the comet returns in accordance with my prediction, posterity will not forget that this first prediction was made by an Englishman."

Halley died a short time before 1759; but the comet duly appeared up to time, and rounded the sun within a month of the date predicted. It came back again in 1835, this time coming within a few days of the time-table which had been drawn up; and in 1910 the time-table proved more accurate still.

But we know now that this wonderful wanderer was not making its first appearance at the time to which Halley traced it back. It has been followed for century after century, and records of its appearance have been found which go as far back as 240 B. C. Of course, it may have been coming and going for long before that. But at least for more than two thousand years this strange visitor has been traveling through space, coming up to our sun every seventy-six years or so, and then wandering away again into the darkness, growing dimmer and smaller as it goes, till it is lost to sight once more.

We are all very much interested in one of its returns. In 1066, when William of Normandy was getting ready to invade England, a wonderful flaming star appeared in the sky. When the people of Britain saw the great comet in the sky they were very much afraid. The people of Normandy were frightened, too, but William himself was not afraid of the comet, telling his soldiers that it was a sign that a kingdom wanted a king. After the Battle of Hastings everybody believed that it had been the herald of William's victory and Harold's overthrow. So, when the Bayeux Tapestry was worked, which tells in needlework the whole story of the Conquest, the flaming star was pic-

Photographed by Rev. Joel H. Metcalf

MOREHOUSE'S COMET

The telescope was made to follow the motion of the comet. Hence, the stars show trails, which indicate how much the comet moved during the exposure of 70 minutes.

tured on it—a wonderful thing, with a head of red and blue, and fiery streamers of different colors, while people stand below pointing to it, and the words are written beside it in Latin: "These are wondering at the star." Now we know that this terrible star of the Conquest was one of the returns of Halley's Comet.

WHAT IS A COMET?

What do you suppose a comet really is? Well, if we could get near enough to one to see how it is actually made, and what happens to it, we should probably see something like this: The head of the comet, which looks like a bright star, would really be like a great swarm of bees; only the bees would be things something like pebbles, and while they all traveled along together, there would be wide spaces between them. When it was far away from the sun, the comet would be nothing but this swarm of pebbles, and would look quite dull and faint. Then, as it came nearer, it would begin to glow and get brighter; and then, in some way that nobody quite understands, the sun would begin to exert a powerful influence upon it, and the swarm would throw up great jets of fiery mist, which would stream away behind it, just as the smoke of a steamer is driven back by the wind. If we could follow our comet century after century, we should see it gradually wasting away, and perhaps splitting up into two or three little comets. And by and by it would vanish, and never be seen again at all—at least, not as a comet.

But it would still leave something behind it to remind us of it. You have seen a shooting star flashing across the sky at night, like a bright streak of light. Well, sometimes these shooting stars, instead of coming singly, come in showers. About November 23 to 27 there is a shower which sometimes sends us hundreds of these bright visitors in a single night. And we know that this shower is all that is left of a comet that came several times round the sun

and was last seen, split up into two, about the middle of the last century.

SHOOTING STARS

This is probably what happens to all comets in the end. The great swarm that makes up the head gets gradually scattered out along the path in which it travels, till at last we cannot see it any longer as a single mass. It is just a long string of pebbles, stretching for millions of miles, perhaps, along its old track. But when our earth, as it rolls along through space, crosses the path where these pieces of the old, worn-out comet are traveling, they rush down with tremendous velocity through our air, getting hotter and hotter as they rub against it, until at last they are quite burnt out. And so a shooting star is just one of the pieces of what may once have been a great and wonderful comet. Now there are some shooting stars which do not seem to have ever belonged to any comet. The big ones that come singly, and that sometimes fall down upon the earth, still quite hot from their rush through the air, seem to travel through space on their own account, and nobody can tell where they came from at the first. But the great showers where hundreds of little shooting stars are to be seen darting across the sky, and all getting burnt out before they reach the earth, are all relics of old comets that have been wandering for no one knows how long, and have gradually got worn out with their long journey.

Courtesy Harvard College Observatory

EL MISTI METEOROLOGICAL STATION, AREQUIPA, PERU

The Arequipa Station of Harvard College Observatory has an elevation of 8,043 feet. Near by the volcanic mountain El Misti rises to 19,200 feet, and on the summit Harvard established and for eight years maintained the station here shown. The air is very rare.

STARS THAT FALL FROM THE SKIES

On the writing table of King Edward VII there stood, besides other costly objects, a plain piece of rock, a rough, unhewn stone about the size of a man's fist. "What a queer letter-weight for a king!" And yet in its way this letter-weight was a costly article. Infinite trouble, terrible dangers, and much science com-

bined to place the stone on the monarch's desk. The leader of the Himalayan Exploration Commission chipped it off at the highest point reached on the mountain to which he gave his name — Everest — to hand it to his sovereign as a symbol of the conquest of the highest point on earth.

"But, if the king could boast of having the highest point of the earth on his writing table," says a German astronomer, "I feel inclined to boast of a stone coming from much loftier realms than even the highest earth-mountain. I own a black, insignificant pebble, which might easily be taken for a bit of coal, and which by rights should find its place in the ash barrel instead of being mounted in gold as a scarf-pin.

"The tiny stone hails from regions never yet penetrated by man; its home is not found on high mountains, nor in ocean deeps, nor in dense jungles, nor in the interior of the earth. It does not belong to our planet at all. It was at one time more distant than the sun, moon and all the planets. Perhaps millions of years ago it traversed the shining belt of the Milky Way; perhaps thousands of years ago it crossed the stars of the Great Bear, perhaps — perhaps!

"And then one fine day a radiant star appeared in its course through the voids of space and the little pebble was drawn within its circle of attraction. With ever increasing rapidity it traveled towards that bright star we call the sun, and the nearer the pebble approached the larger the sun-star grew, until it loomed out as a huge ball of fire around which other balls revolved. Our stonelet rushed boldly on towards one of these globes; this became larger and larger, whirling clouds grew visible, then oceans and land, for it was our earth, and finally it dragged our pebble down towards it with tremendous speed. It dashed down through cloud wrappings in a white-hot glow from its swift journey, splintering into many pieces and falling on the ground in sparklets. Then people who saw its fall cried out, 'A meteor! A shooting star!' Our little stone lay at peace after a journey which may have lasted millions of years, past huge worlds which we see only as small stars. It is one of these tiny stones I wear in my scarf-pin."

THE STARS

THUS far we have talked about only the big letters, the capitals that go to make up the golden lettering of the great open book of the heavens. Now we can turn to the small letters, the fixed stars, whose tiny twinkling points dot the whole heavens. These are the stars proper, — not planets or comets or shooting stars or moons, not even parts of the sun family, — but suns themselves so far away from

METEORIC STONE FOUND BY PEARY, NOW IN MUSEUM OF NATURAL HISTORY, NEW YORK

us that they appear like points of light. As we study them, we shall find that they make up the pictures in our book of the heavens.

STAR GROUPS, OR CONSTELLATIONS

These star pictures, made by groups of stars in the sky, are always the same. They never change their shape. When we say that, we have stated the most remarkable fact that we could about them. Of course they move. They both *seem* to move, because our earth turns round, and they actually *do* move on their own account, traveling hither and thither in space. But they keep the same position with relation to each other. So that though a group

A STUDY OF THE CONSTELLATION FIGURES PICTURED BY THE ANCIENTS

— or constellation, as it is called from the Latin words *stella* for "star" and *con* for "together"— is actually moving, and shows in a new part of the heavens, yet the picture, even though it be upside down, stays the same, and has stayed the same for all the thousands of years we can know anything about.

Think a minute about what this means. There these stars stood when, thousands of years back, the cave men of the Stone Age represented the flower of mankind; and there they stood when, thirteen hundred years before Christ, Egypt's great king, Rameses II, whose dried-up mummy curiosity has so rudely torn from its many centuries' repose, marshaled his huge forces in war against the Syrians. Columbus saw them when he peered out anxiously for the desired land at dead of night; Napoleon saw them in the great steppes of Russia; and Nansen watched them sparkle in the ice and snow regions of the Pole, far away from all civilization. And yet we know that these stars dart hither and thither with great speed; that the stars which apparently group them-

THE CONSTELLATIONS AS YOU SEE THEM IN FEBRUARY AND MARCH

selves together in certain figures — constellations — are in reality divided by huge distances, and that their nearness to each other is due only to an accidental perspective. Measurements have convinced us that some stars move through the universe at a speed of many thousand miles a minute; some members of a constellation may approach and recede from each other, while others wander away together through the infinite. Although this takes place at a tremendous speed, yet their distances from us are so immense that they have appeared for thousands of years in their old shape, as though the stars forming these constellations stood immovably still.

Even the names by which these star pictures are known have come down to us for thousands of years. People who studied the stars in the earliest days fancied they saw all sorts of figures among them, — figures of men and women, beasts, dragons, and ships. They named the star groups after these figures, and these names, or our English translations of them, are the names by which they are still known. Some of

the constellations seem to us very like the names which they bear; for others it takes a pretty big imagination to see the likeness to the figures for which they are named. But we can always trace out the stars which make up the group. Finding them and trying to see the pictures, both the easy ones and the hard ones, is the fun of star-gazing, and nobody wants a puzzle to be always easy.

MAKING FRIENDS OF THE STARS

Every boy and girl should learn to find a few of the constellations. It is easy to do, and when you have learned the names of the bright stars, and the positions of the constellations, you will be surprised to find how interesting it becomes to look up at the sky on a clear night, for the stars seem like friends as we see them twinkling away in the heavens.

If you are to be a star-gazer, there is one thing you must remember; that is, that the appearance of the starry heavens changes with the seasons. If the different stars were always in just the same direction from us, star-gazing would lose most of its interest. If the Great Bear or Sirius were in exactly the same place every night, we should find them once for all and be done. Not only do the stars appear to go round the earth once in twenty-four hours, but, owing to the apparent motion of the sun, the stars appear to rise and set four minutes earlier every night. The result is a constant change, gradual but steady, in the position of the stars at any given time, and at the end of the year the entire circuit is completed and the stars return to the places which they occupied a year before. One star in the heavens, however, scarcely changes its position at all. This is the star which you must learn to find first.

THE POLE STAR

Suppose you look up at the sky on a clear night. You will see a great number of stars — so many that it is impossible to count them; and you will notice that these little stars are all moving across the sky. Stand where you can see a tall tree or a church spire against the southern sky, and watch a bright star close to it on the east side. In a few minutes the star has come to the edge of the spire; then it passes behind it, and is out of sight for a while; and then it comes out again on the west side, and begins to move away. And all the other stars in the sky are doing exactly the same — all moving from east to west — except in one place. If you turn and look up to the sky in the north, you will see one fairly bright star which does not seem to move at all; and the stars that are quite close to it move so slowly that you can scarcely notice their motion.

All the stars in the sky seem to move in circles round this star, the ones nearest to it in small circles, and those farther away in larger circles, till you come to the ones whose circle is so big that you can see only half of it, as they rise in the east, pass right across the sky, and set in the west.

This is the Pole Star. It is directly above the North Pole, and is called "Polaris," or the "North Star." This is the star around which all the northern stars move; but when you have found it you must prove this is true by going out at night and watching it. Some things which are said in this book you have to take on faith, because you cannot go out for yourself and prove them. As a star-gazer you can and should prove every word for yourself. Watch Polaris and see if the stars above it, those higher up, do move from your right hand towards your left hand (from east to west) and those below from left to right (west to east).

THE POLE STAR AND THE BIG DIPPER

The Pole Star is usually easy to find because it is the brightest star in that part of the heavens. But if you cannot find it quickly, it has two faithful friends in the heavens which will guide you quickly to it. These are two stars of the Big Dipper. Very likely you know the Dipper already. If you don't you can easily find it in the sky on any clear night. It has seven stars, in the shape shown in the picture, and they are always in the north somewhere. Having found the Big Dipper, you can use two of its stars, the two bright ones, which make up the very front part of the Dipper, the part of the bowl away from the handle. Imagine a line drawn through these two stars,

OUR COUSIN PLANET, MARS

Are there really "canals" on Mars, or are the apparent lines only a conglomeration of spots at such distance from each other that they cannot be seen separately? These drawings in the "Illustrated London News" show (1) (4) the network of "canals"; (2) that in 1909, when Mars came unusually near the earth, the network was not seen when the largest telescopes were used; (3) that dots can produce lines resembling the "canals;" (5) is highly imaginary. So the discussion by the astronomers goes on. Professor Lowell holds to the canal theory.

and it will always point to the Pole Star. These are the Pointers. Sometimes you will find them below the Pole Star pointing upward; or they will be above it, or off to the left or right; but as the Dipper moves round the northern sky they will always be doing their task of pointing the way to the Pole Star.

THE GREAT BEAR

The stars of the Dipper are part of a group which is also called the "Great Bear." It is harder to see a bear in them than a dipper,

THE DIPPER CIRCLING AROUND THE POLE STAR

but perhaps you can find him from the picture. Besides the Great Bear there is, not far from it, the Little Bear, which is really very like it, only smaller and harder to find. The Pole Star is the last star in its tail; from it two small stars lead away parallel to the Great Bear, and they bring the eye to a small pair which form one side of a square just like that in the Great Bear. But the whole of the Little Bear is turned the opposite way from the Great Bear, and the tail points in the opposite direction. This is also called the "Little Dipper." Perhaps you can find it more easily if you know that the handle of the Big Dipper is bent *back*, while the handle of the Little Dipper is bent *in*.

A STAR BEAR STORY

We like to keep the names of Great Bear and Little Bear because of the story that goes with them. Once upon a time the great god Jupiter fell in love with an earth princess named Callisto. Jupiter's wife, Juno, was very angry at this, so she changed Callisto into a bear. But Callisto had a son Arcas. While Callisto, in the form of a bear, was wandering about the woods, she met her son Arcas, and forgetting her changed form was about to embrace him when Arcas, not understanding, raised his hunting spear to strike her. Jupiter saw them and took pity on them, snatching them both up into the sky to save Arcas from the crime of killing his mother. There they became the Great and Little Bear. But Juno was very angry at all this. She went to the wife of the Ocean and said, "Promise never to let these bears come to your water." So the wife of Oceanus promised, "I will never let them sink below our waves." That is why the Great and Little Bear never set. They whirl round the Pole Star, but they never venture to dip their huge bodies beneath the horizon.

STARS TO TEST YOUR EYESIGHT

Study out the Great Bear, or, if you find the Big Dipper part of this constellation easier, look just above the second star from the end in the handle of the Dipper, and see if you can find a fairly bright star and near it a smaller one. The bright star is Mizar, while the small companion star is Alcor. Some people say they make part of the Great Bear's tail. They have Arab names, and the story is that the Arabs used these two stars as a test for eyesight, and any Arab who could not see Mizar and Alcor was not allowed to serve as a soldier. Find them first with an opera glass, if you do not place them at once; then look with the naked eye and see whether the Arabs would have taken you as a soldier.

THE GUARDS

Between the Pole Star and the Great Bear you will see two small stars, at no great distance from each other. These are the "Guards."

As the stars circle round the Pole Star, you will find that no matter what part of the sky the stars may be in, whether it be during the winter

THE GREAT AND LITTLE BEAR

or the summer, the Guards will always be in a position between the Great Bear and the Pole Star. People of old thought that the Great Bear wanted to get at the Pole Star, so that he might add it to his stars. So, they said, the gods had put the Guards in between the Great Bear and his prey, to prevent him from reaching the Pole Star. The Guards, therefore, will always be found on duty, keeping the Pole Star safe.

CASSIOPEIA

If we learn the position of the Great Bear and also of the Pole Star, they will help us to find many of the other constellations. There is an old rhyme which says:

"He who would scan the figured skies,
Its brightest gems to tell,
Must first direct his mind's eye north
And learn the 'Bear' stars well."

Now, if you look at the sky on the opposite side of the Pole Star from the Great Bear, you will see a clearly marked capital W made up of five or six bright stars. This is called "Cassiopeia," or the "Lady's Chair." Cassiopeia, as you will see when you look for the W in the sky, lies on the course of the Milky Way. If you follow the Milky Way to one side, you come to Cepheus, which is not a very interesting group; but if you go to the other side, you come upon a bright group of stars called "Perseus," and beside Perseus, but outside of the Milky Way, lies Andromeda, or the Chained Lady. Andromeda is rather badly marked, but you may know it by a line of three pretty bright stars which lead to a great square formed by four bright stars. The great square, which you will easily recognize, is part of the constellation called "Pegasus," or the "Winged Horse."

All these names belong to the old Greek story which tells how Andromeda, the daughter of King Cepheus and Queen Cassiopeia, was chained to a rock on the shore, to be devoured by a sea monster, and was saved by the hero Perseus. Perseus showed the monster the snaky head of Medusa, the sight of which, you remember, turned even this dreadful dragon into stone. Cetus, the sea monster, has also been made into a constellation: but he has no very conspicuous stars.

CAPELLA

If you draw an imaginary line across the two stars forming the backbone of the Bear, starting from the end nearest the tail, and continue it onward for a good distance, you will come to a very bright star called "Capella," which you will know because near it are three little ones set in a triangle. If you haven't found it easily from the Great Bear's tail, start with the star that is at the bottom of the Dipper and nearest the handle. Draw in your mind's eye a line halfway between the two Pointers and keep on till you come to the first bright star. This is Capella.

Capella makes part of a beautiful five-sided figure, which some people call the "Charioteer." It is the second brightest star in the northern heavens. In the olden days they sometimes called this five-sided figure "the goat-carrier." Capella means "little goat." The shepherds used to watch these stars and call the three little ones near Capella "the kids." Sometimes they thought they could see a man carrying them in his left hand, while Capella went along beside. So the constellation was to them "the goat-carrier."

VEGA

Capella is the second brightest star in the northern heavens. Vega is the brightest. She is part of a constellation called the "Lyre," or "Harp"; but just now you should look at her by herself. She is on the other side of the Pole Star from Capella. She shines with a steel-blue light. Vega is so far off that the light from it which reaches our eyes has been traveling since a time before many of you were born. It is one of those stars of the first size or magnitude which remind us that these stars at which we are gazing are really suns.

Vega is a very beautiful star, but the most interesting thing about it is that it marks the point of the sky towards which our own sun, with the earth and all the other worlds of our family, is traveling at a speed of more than one million miles every twenty-four hours.

THE STAR-CLOCK OF THE NORTH

Remember that the Great Bear and Cassiopeia never set in our northern sky. As they move about the Pole Star they have been called "the Great Star-clock of the North." "To watch these northern constellations as they follow each other in ceaseless procession round the Pole," a great astronomer has said, "is one of the most impressive spectacles in the sky. We are spectators of the movement of one of Nature's machines, the vastness of the scale of which, and the absolutely perfect smoothness and regularity of whose working, utterly dwarf the mightiest work accomplished by man."

STAR MAGNITUDES

We spoke of Vega as a star of the first size or magnitude. This is a phrase borrowed from the old days, when men did not realize that the stars might be at all sorts of different distances away from us, but thought that the star which shone brightest was of course the biggest star. We know that a small star comparatively near may look larger to us than a great one farther away. But the word "magnitude" was used when men really thought stars were large or small according to their appearance, and so it is used to this day. They called the biggest and brightest "first magnitude stars." Of these there are not many, only about twenty, in all the sky. The next brightest — about the brightness of the Pole Star and the stars in the Great Bear — are of the second magnitude, and so on, each magnitude containing stars less and less bright. When we come to stars of the sixth magnitude we have reached the limit of our sight, for seventh magnitude stars can be seen only with a telescope.

THE MILKY WAY — THE RAINBOW'S SISTER

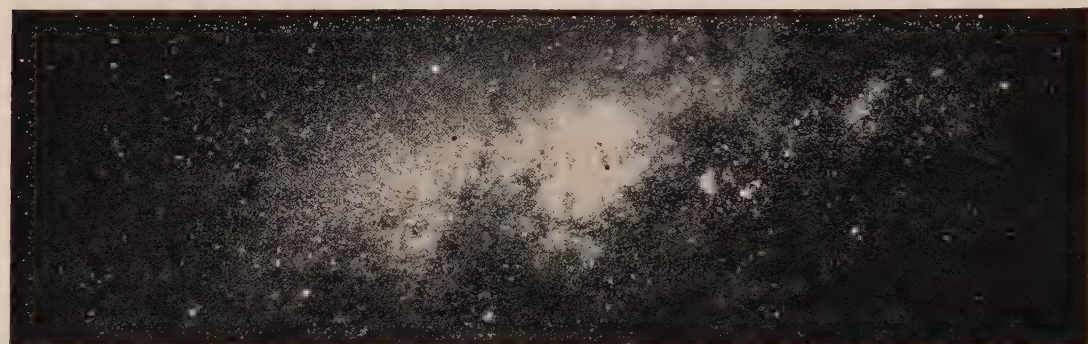
In looking at Cassiopeia you cannot help noticing that there is a zone or broad band of very many stars, some exceedingly small, which apparently runs right across the sky like a ragged hoop, and Cassiopeia seems to be set in or on it. This band is called the "Milky Way," and crosses not only our northern sky, but the southern sky too, thus making a broad girdle round the whole universe. The ancient Mexicans called it the "sister of the rainbow." This delicate ribbon of light winds like a misty, gleaming veil in and out among the radiant stars and starlets, and when, on clear wintry evenings, the dark skies seem to extend without a limit and the heavenly lights stand out like diamonds on a velvety background, this mighty belt of light glitters in enhanced radiance, as if composed of millions and millions of the tiniest sparklets. It is the Milky Way.

CASSIOPEIA IN HER CHAIR

SOME INGENIOUS SUGGESTIONS

The fable runs that Hercules, when a giant baby drinking at the breast of Alcmena, spilt a drop of milk, which ran down into the skies,

spreading farther and farther, its trail forming the Milky Way. Theophrastus declared the gleaming ring to be the place where the two celestial spheres were joined together, and other wise men of ancient times believed it to be the route of the sun-chariot, the Milky Way being the hollows which the wheels had worn in their journey lasting thousands of years. They had an easy, offhand method of explaining the universe and its immeasurable glories in those distant times! To-day we know this radiance to be due to the presence of millions of stars, millions of suns floating in space vast distances off. Democritus, indeed, a philosopher who lived five hundred years before the Christian era, shrewdly surmised that the Milky Way consisted of endless numbers of small stars; but it was left to Galileo and his telescope to justify this supposition by announcing its truth.



Courtesy Harvard College Observatory

THE MILKY WAY IN SAGITTARIUS; THE TRIFID NEBULA IS NEAR THE CENTER

WINTER SKY PICTURES

The figures of the northern star-clock are visible all the year round, but other constellations can be seen only in their seasons. In winter Capella gets high up into the sky, and then there is to be seen below her a little cluster called the "Pleiades." There is nothing else like this in the whole sky. It is formed of six stars, as it appears to persons of ordinary sight, and these stars are of about the fourth magnitude. Some eyes can see more than six. But though small, they are set so close together, and appear so brilliant, twinkling like diamonds, that they are one of the most noticeable objects in the heavens. A legend tells that there were once seven stars in the Pleiades clearly visible, but the seventh is very faint now.

There is a mention of the Pleiades in the Bible, in the Book of Job, written fifteen hundred years before Christ:

> "Canst thou bind the sweet influences of the Pleiades,
> Or loose the bands of Orion?"

ORION

The most beautiful constellation in the whole winter sky is Orion, the Great Hunter. Right in front of you, as you look south on a midwinter evening — say in January — you will see him. Three bright stars, at equal distances from each other, make a slanting line across the sky. They are supposed to be the belt of a great giant, whose shoulders are marked by two stars higher in the sky. Two others, about the same distance below the belt, mark his knees, while a little group of three faint stars stands for his head, and a curved line of twinkling jewels below the belt makes his sword.

Over his left arm hangs a lion's skin which he holds out to shield him from the starry bull which is to attack him, — four faint stars in a curve giving its outline. In his right hand he holds a club with which to strike. Seven stars in a rather poor curve make the arm and the club. Do you see them in the picture on the next page?

The Bull (*Taurus*, the Latin word for "Bull") is right opposite to him, and easy to find. See where Orion is going to strike. There is a

triangle, or a big V. Five stars make it up, and the brightest of them, that very red star at the top of the left side of the V, is the Bull's red eye, glowering at the Hunter. Some people say the whole V is his face, and this is the brightest part of it; others think the tops of the V are the tops of the Bull's ears, and they do not count the stars beyond, which might be horns, great tall horns which reach up almost to Capella. Only the head of the Bull is shown in the heavens; but Orion has with him also his dogs. Look a little to the left, and lower down than Orion, and you will see the Big Dog. Sirius, the brightest star in the whole heavens, is to be seen in this constellation, and because it is the chief star in this group is often called the "Dog Star." Everyone ought to know Sirius. Near by, but higher up, is the Little Dog. They are both chasing along at Orion's heels, with the dog's fidelity.

The story is that the goddess of the moon had fallen in love with Orion, the mighty hunter. Her brother, the god of the sun, did not approve at all. He ordered the moon-goddess to give up Orion, but she would not. So he resolved to destroy Orion. One day, as Orion was bathing in a pool, the sun-god sent his brightest rays upon him, making him shine like a piece of bright gold. Then he called to his sister and said, "See that bright spot in the water. Let us see which of us can hit it." The moon-goddess, eager to show how well she could shoot, sent her arrows swiftly to the spot, and Orion sank, pierced to death. The moon-goddess was in great distress. She went to the sun-god, and begged him to give back Orion's life. He could not grant this, but lifted him to the sky, where the moon-goddess, traveling by in her chariot, might look at him, and gave him his two brave dogs, which had always followed him on earth. Even in the heavens, Orion is a hunter and is trying to kill the Bull, who is attacking him.

THE TWINS, THE NORTHERN CROWN, AND ARCTURUS

Northeast of Orion are to be found two bright stars of nearly the same size; these are the Heavenly Twins, or Gemini.

Returning now to the Great Bear, we find, if we draw a line through the middle and last stars of his tail, and carry it on for a little distance, we come presently to a cluster of stars in the form of a horseshoe; there is only one fairly bright one in it, and some of the others are quite small, but yet the horseshoe is distinct

ORION, THE BULL, AND THE DOGS

and very beautiful to look at. This is the Northern Crown. The very bright star not far from it is another first-class star called "Arcturus." Arcturus is the brightest star in the constellation Boötes, or the Herdsman.

Arcturus is a summer star, and the Herdsman a summer constellation. Besides Arcturus, you should know Antares, one of the summer stars belonging to the spider-like constellation of the Scorpion, which you can see in the pictures and so trace in the sky. Indeed, now that you have found a few constellations with the help of the Pole Star and the Bear, the best thing for you to do is to take these pictures or a monthly sky map, such as you can buy, and trace out for yourselves the figures which are

shown. You will find many more stars and constellations which will soon come to be old friends.

THE ZODIAC

One set of twelve constellations, which made up the sun's path during the year through the heavens, — on the old plan that the sun moved and so would have stars always behind him, — is called the "Zodiac." You should know about it, for its signs have become famous in literature and pictures, but you will not be able to trace the full path across the heavens. The Greek word means "animal circle," and this belt of stars was so named because most of the figures on it were named for animals. The belt is also divided into twelve parts called "Signs of the Zodiac" or "Houses of the Sun," because the sun was supposed to visit in them. Their names are given in a rhyme which helps us to remember them:

> "The Ram, the Bull, the Heavenly Twins,
> And next the Crab, the Lion shines,
> The Virgin and the Scales;
> The Scorpion, Archer, and He-goat,
> The Man that holds the watering-pot,
> The Fish with glittering tails."

The Bull, the Twins, and the Scorpion you have already met. It was a wonderful imagination that thus pictured the heavens, and filled them with charming stories.

INCAS OF PERU WORSHIPING THE SUN

Sun worship has been common to many peoples from the earliest days, and is still practiced in some form among most of the primitive peoples.

THE GREAT STAR-GAZERS

ASTRONOMERS EVERYBODY SHOULD KNOW

THE story of astronomy is the life story of men, men who all down the ages have spent their lives reading the wonderful open book of the heavens. The name of the first astronomer will never be known, — some Chinese star-gazer perhaps, some shepherd watching his flocks by night and studying the stars as he watched, or some Wise Man of the East who studied the movement of the stars in their courses. Old Chinese chronicles say the stars were studied in 3000 B. C. Astrology was famous among the Babylonians, Egyptians and Greeks.

OUR ZOÖLOGICAL SKY GARDEN

ZODIAC SIGNS: 1. The Bull; 2. The Twins; 3. The Crab; 4. The Lion; 5. The Virgin; 6. The Scales; 7. The Scorpion; 8. The Archer; 9. The Ram; 10. The Water-bearer; 11. The Fishes; 12. The Goat. From a very old print.

The first astronomer about whom we know is Thales, one of the Seven Wise Men of Greece, who was born in 640 B. C. and died in 556. He was the first to draw maps showing the position of the stars in the heavens. In 550 B. C. Pythagoras taught that the earth was not a disc surrounded by water, but a globe. He opposed the view of Thales that heaven was a huge crystal bell set over the

FOUR FAMOUS OBSERVATORIES

1. The Ancient Observatory at Peking, China. 2. The Harvard Observatory at Arequipa, Peru, especially for observing the southern sky. 3. The Yerkes Observatory of the University of Chicago, near Lake Geneva, Wisconsin; this has the largest refracting telescope in the world. 4. The Lick Observatory in California, with a mountain location unusually favorable.

PTOLEMY COPERNICUS TYCHO BRAHE KEPLER GALILEO

earth, and the stars gilt-headed nails driven deep into it.

Aristotle, a Greek philosopher, was interested in astronomy, and ventured to suggest that the earth might be round. The next man to give his life to the study of astronomy was Hipparchus, a Greek scholar, who was born about 170 B. C. He made a catalogue of the stars, and was able by his study of the movements of sun and moon to predict quite accurately their times and seasons. Hipparchus was the greatest of all the ancient astronomers, "a most truth-loving and labor-loving man," as Ptolemy described him.

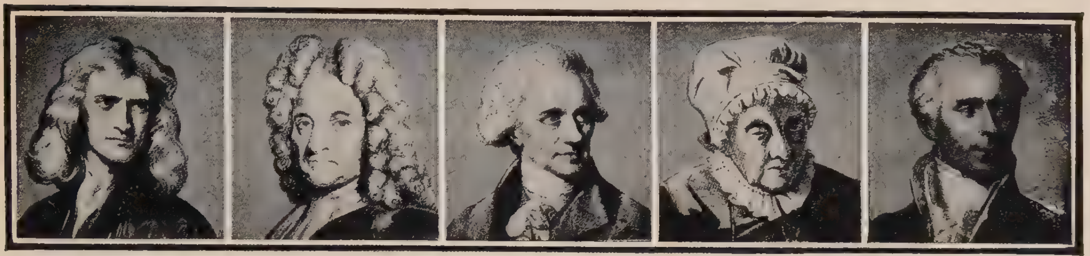
PTOLEMY AND COPERNICUS

The size of the earth was determined for the first time in the year 230 B. C. by Eratosthenes, a Greek astronomer and geographer, who also made a catalogue of 675 fixed stars.

Ptolemy, an Egyptian, lived two hundred years later. His theory of the earth as the solid center of the universe was held by the world for fourteen hundred years, until it was upset by Copernicus (1473–1543) and his successors. It is hard for us to realize what a serious matter it was for a scholar of the Middle Ages to advance a theory which was in opposition to accepted teaching. Ptolemy's idea had been adopted as reasonable and satisfactory. Man was the lord of the universe, living on the earth which was the center of all things. When Copernicus became convinced that the earth was not the center of the universe but simply a small member of the sun family, all moving round the sun instead of the sun, moon, and stars revolving round the earth, he knew that the publication of his theory would be received with ridicule and perhaps persecution. He therefore did not publish his book until shortly before his death. He might not have published it at all, but left it among his writings, if a young student of his had not prevailed upon him to have it printed. Copernicus was an old man when he made this decision, and was on his deathbed when the first printed copy was brought to him. To appreciate the genius of Copernicus we must remember that he lived in a time when the belief was universal that the earth stood still and the other worlds moved round it, that he spent, as he declares, thirty-six years after his great idea came to him in patient study toward its confirmation, and that he did his work before the invention of the telescope. Little attention was paid to his discovery except among learned men, but he stands on the threshold of the new astronomy.

TYCHO BRAHE

Three years after the death of Copernicus, Tycho Brahe (1546–1601) was born in Denmark. A rich young nobleman, while he was at the university the event happened which directed the course of his whole life. There was predicted an eclipse of the sun, and the boy Tycho, with his companions, watched for it on August 21, 1560. When it appeared at the right time, and he saw this strange shadow put out for the time the light of the sun, his enthusiasm was aroused. From that moment he gave all his spare time and money to the study of astronomy, purchasing instruments for star observation and sitting up half the night to watch the heavens. He could not quite believe with Copernicus that the earth moved round the sun, but he made a most careful study of the stars, collecting a wonderful array of accurate facts. His reverence for the wonders of the heavens was so



NEWTON HALLEY WM. HERSCHEL CAROLINE HERSCHEL LA PLACE

great that he used to put on robes of state when he went to his observatory to study them with his instruments, which were the best any astronomer had ever made. He spent twenty-one years in observation of the heavens, discovering new stars, and new facts about old ones, and devoting himself especially to investigation of Mars, the moon, and comets. To him we owe the foundation of that accurate observation which has made astronomy the most exact, the most wonderful of all sciences.

THE FAMOUS STAR-STUDENTS OF THE MIDDLE AGES

Modern astronomy begins with the next group, of whom the leading figures were Galileo and Kepler. Tycho Brahe had collected facts. He left his records to John Kepler, a German, born in 1571, who set himself to study out from this array of facts a set of laws. Kepler accepted the belief of Copernicus, and tried to fit Brahe's careful observations into it; but he found, for instance, that on the plan of the planets moving in perfect circles, the time when Mars should be in a certain place was eight minutes different from the actual time. Brahe was too careful an observer to be eight minutes out of the way. So Kepler came finally to question that old, first theory of the ancients, which everyone since had held, that the planets all move in perfect circles. He tried the plan of an oval path, an ellipse, such as we have seen to be the path of the earth. By it all the times proved to be just right, and Kepler's *first law*, the law of ellipses, was proved.

He next tried to find out at what rate planets moved in different parts of their orbits, and was able to work out laws of the time which they took to travel their paths, as related to their distances from the sun, and also their actual distances from the sun. Kepler was poor, and the story of his struggles for money to keep up his studies is pathetic. But he finally proved his laws, and his delight was unbounded. In the book which gave his discovery to the world he said, "The die is cast, the book is written, to be read either now or by posterity, I care not which; it may well wait a century for a reader, as God has waited six thousand years for an observer." Kepler also published tables made from Brahe's observations, which are the foundation of our Nautical Almanac, paying himself, no one knows how, for the expensive type to set it up because he could get no one to advance the money. What Kepler did for astronomy it is hard for us to realize. Many men could collect facts, but the man who had the wisdom and patience to spend his life pondering over them and working them into laws, which could be counted on for all time, did a service which made a new period of astronomy.

THE GREAT GALILEO

While Kepler was working in Germany, Galileo (1564–1642, born in Pisa) was carrying on his experiments in Italy. He first found out the principle of the pendulum by which many of our clocks are run, and of many other scientific truths. But his service to astronomy came through the fact that he was the first man to turn the telescope on the heavens. Up to this time all the study of stars had been with the naked eye, unaided by any instruments. With the use of the telescope Galileo opened a new world to astronomers, and found in it, as we have seen, many interesting and wonderful things, some of which he could interpret, some he could not. It shows the

THE MOON, PHOTOGRAPHED THROUGH A TELESCOPE

Telescopes bring the moon so near that its mountain peaks, casting harsh, black lunar shadows, and its volcanic craters can be plainly seen. The State of Rhode Island could be fitted into one of the huge craters, and there would still be room to spare.

KEY TO THE PHOTOGRAPH OF THE MOON, WHICH HAS BEEN ATLASED

The massive and extended ranges are in the moon's northern hemisphere. The peak Mt. Blanc is 12,000 ft. high. The craters Aristoteles and Eudoxus are among the great "ring-mountains."

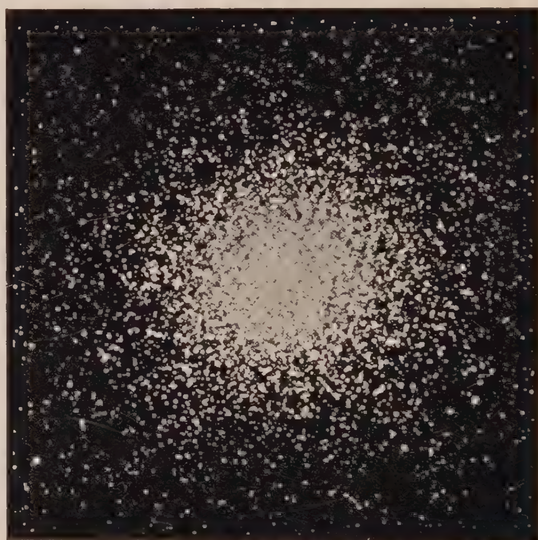
strength of the old views that in these years, while Galileo was making discoveries along the line of the Copernican theory, he was obliged by the university in which he was professor to teach to his students the old Ptolemaic system. The relation between these pioneer astronomers is interesting to follow out. Brahe left his charts and figures to Kepler, for him to continue the study which death compelled him to give up. Kepler sent Galileo one of his books, and Galileo wrote back: "I count myself happy, in the search after truth, to have so great an ally as yourself. . . . I should certainly venture to publish my speculations if there were more people like you." When Galileo did make his notions public, his prophecies of persecution were fulfilled. He was brought before the authorities in Italy, every copy of his book was seized and burned, and he was compelled to kneel before the opposing officials and declare that he would in future "detest the false opinion that the sun was the center of the universe and that the earth moved." Rising from his knees, tradition says, he whispered to one standing near him, "For all this, it does move." Even after this, he was imprisoned, then removed to his home, to live under guard in perpetual solitude. For the last four years of his life he was blind.

THE MODERN GROUP

Galileo had given the world the law of bodies falling to the earth. It was Sir Isaac Newton (1642–1727), an Englishman, who applied this theory to the world of planets and gave the answer to the question, "What binds the sun system together?" Kepler had found out the laws of the motions of the planets. Gravitation, as Newton worked it out, was the greatest discovery ever made in the history of astronomy. By extending the theory of gravitation to the movement of the moon round the earth, Newton showed that the laws which Kepler had discovered were the laws of universal gravitation. To him we owe the great law, known as the Newtonian law, that "every particle of matter in the universe attracts every other particle." The far-reaching effects of this law were not fully grasped even in Newton's day. Newton also made important discoveries in the nature of light. He was not a rich man, and would not have been able to pay for the publication of the book containing this discovery, had not his friend, Edmund Halley, the discoverer of the comet of his name, had the book published at his own expense. Newton received more worldly honors than those who had preceded him. The value of his discoveries was recognized in his lifetime, and he was given titles and presents.

Halley was the next noted English astronomer and found out many facts about Venus as well as about comets. James Bradley and James Ferguson, both friends of his, were also of service to the cause of astronomy.

Bradley helped to change the calendar of England from the old calendar to the one we use. He attacked the problem of the distance of the stars, and in this work discovered "aberration of light." This depends on the motion of the earth. We can get the idea while walking in the rain, when the drops are coming straight down. The faster we walk, the more we have to tip our umbrella forward for protection. Thus, when the earth is moving so fast athwart the direction in which the light is streaming from the stars, the stars appear displaced forward. Ferguson was a Scotchman. His name should be remembered for three things:



Courtesy Harvard College Observatory

STAR CLUSTER IN CENTAURUS; THE FINEST GLOBULAR CLUSTER IN THE SKY

he made important observations, he constructed extraordinary instruments and machines, and he gave lectures and did much to make astronomy popular. It was, besides, his book on astronomy which started William Herschel on his career as an observer of the heavens.

Astronomers before Herschel had occupied themselves only with the solar system, the little group of planets moving round the sun. The stars were observed, but mostly as convenient reference points for the observation of the moon and the planets. It was left for Herschel to begin the conquest of the stars, to start astronomy on a new path. On his tombstone it is written: "He broke the barriers of the skies"; and it is true. He stands second to Newton among the pioneers. He was born at Hanover in 1738, and was trained as a musician to play in the band of which his father was leader. After a time he went to England, and there set up a home with his sister Caroline. He began to take a deep interest in astronomy, and as he was too poor to buy a good telescope made one himself. But for his sister he could never have become an astronomer. She helped and encouraged him in all this work. Sometimes he had to hold his hands on parts of the telescope for sixteen hours, and she would give him his meals and read to him to break the monotony of the long hours. With this telescope Herschel discovered the planet Uranus, and from this moment was a recognized and honored astronomer. Together the brother and sister worked, discovering, it is said, about seventy million stars with his mighty telescope, besides many star clusters. When you learn that as you look up at the heavens when there seem to be a great many stars, you do not see more than two thousand, you begin to get a little idea of what a new world Herschel opened. He was king's astronomer, and his discoveries made such a stir in the world that sometimes he would have to be for days together "the showman of the heavens," pointing out to others the wonderful sights he had seen.

Since Herschel's day many great men have devoted their lives to the study of the heavens, but those whom we have named are the pioneers of astronomy, the men who made the first steps in the conquest of the unknown.

TABLE OF STATISTICS OF THE MEMBERS OF THE SOLAR SYSTEM

Name and Sign of the Planets	Distance from Sun in Millions of Miles	Time of Revolution round the Sun	Equatorial Diameter in Miles	Mean Speed of Revolution per Second	Mass in Proportion to the Earth (Earth = 1)	Number of Satellites
Mercury ☿	36	About 88 days	2,993	29¾ miles	0.05	0
Venus ♀	67	" 225 "	7,438	21¾ "	0.81	0
Earth ♁	93	" 365 "	7,926	18½ "	1.00	1
Mars ♂	142	" 1 year 322 "	4,191	15 "	0.11	2
Asteroids ②	136 to 490	" 1¾ to 12 years	1 to 478	8 to 15 "	—	—
Jupiter ♃	484	" 11 years 315 days	89,330	8 "	314.5	8
Saturn ♄	887	" 29 " 167 "	75,811	6 "	94.1	10
Uranus ♅	1,785	" 84 " 7 "	36,787	4¼ "	14.4	4
Neptune ♆	2,796	" 164 " 284 "	31,071	3½ "	17.0	1

	Distance from the Earth	Revolution round the Earth	Diameter	Mass in Proportion to the Earth (Earth = 1)
Sun ☉	93 million miles	—	864,000 miles	329,000
Moon ☽	238,851 miles	27 days 7 hrs. 43⅛ min.	2,160 "	0.0124

THE MOUNT WILSON SOLAR OBSERVATORY, CALIFORNIA

See also Volume 11, pages 156 and 157.

THE GRAND CAÑON OF THE COLORADO

MONTREUX, IN THE ALPS OF SWITZERLAND

THE EARTH A STORYBOOK

HOW TO SPELL OUT THE SECRET RECORDS OF THE ROCKS

And Nature, the old nurse, took the child upon her knee,
Saying: "Here is a storybook thy Father has written
for thee." — LONGFELLOW.

THE earth is her own story teller. She has kept a diary, a book written by herself, which has mountains and rivers, valleys and volcanoes, caves and ocean-shores for its pages. Some of the records were put down thousands of years ago, and are rather hard to read; others are only a few hundred years old; still others are being written to-day, and we are watching them in the making.

Before men had read the book of the heavens aright, they could not tell the true story of the earth. Only when they had studied the sun, moon, planets, and stars, and had found out that the earth was only one small planet in the solar system, could they begin to understand how this little planet of ours came into being.

HOW OUR EARTH WAS MADE

"In the beginning, God created the heavens and the earth." That is the first word. That goes back of everything. "And the earth was without form and void." There our story begins. It is only a story, for no one really knows what happened in those days before Man was created. But it is very probably a true story, for it is the story that the wisest men in the world have told to account for the many facts which they have observed. This is the way they begin their story: Suppose we imagine a fiery mist, what scientists call a "nebula," which is another word for cloud. This mist would be made up of gases and star-dust, perhaps of metals in liquid form, all so intensely hot as to give out light. That is what the solar system began with. This mass whirled and whirled and finally began to break up into smaller mists. One of these was the nebula which was to make our world, and with it at that time was the nebula which broke off and made our moon. As the parent nebula, the sun, whirled about, it threw us off, as it did all our planets. We were then rolled into a ball by the spinning motion which started us off. We were once as hot as the sun is, but being

smaller we cooled more rapidly. Our nebula began to condense or to grow thicker and harder, as milk thickens into cream. It was whirling all the time, and at first was just a globe, hardly different in look from a whirling flame. Then it cooled and its gases thickened into liquid, as steam condenses into water, for though the nebula was hot it was always traveling through cold space. Gradually it became part liquid and part gas. Then it cooled more, whirling all the while, till at last the first crust of solid matter began to form on the liquid surface. This crust began to thicken, but it was always being broken through by the surging of the liquid masses inside. Just as the moon now pulls water and makes tides, so sun and moon then would be pulling on these flowing liquids, and would make them burst through the surface. Then there would be tremendous surges of melted matter, to which our volcanoes would be as nothing. Photographs show us the huge craters of dead volcanoes on the moon. The moon was being made as the earth was, and the craters are the signs which tell of the tremendous floods of liquid breaking through the crust in which they were imprisoned.

WHY WE HAVE OCEANS AND MOUNTAINS

Later the solid surface hardened irregularly, and into its larger dimples, where the inside liquids did not press so hard, water settled, deepening into our ocean basins. The great outflows of hot liquids grew fewer as these cooled into solids, and as they cooled they also shrank, and the earth's crust shrank with them, leaving great cracks and uneven places, mountains and valleys, paths for lakes and rivers.

SIX THOUSAND MILLION MILES OF GLOWING GAS

Out of a fiery vortex such as this our earth and the entire solar system must have emerged so long ago that we cannot conceive it. Systems in much the same condition can still be seen in the sky, whirling through space with a velocity with which nothing in this world can compare.

LONG-NECKED PLESIOSAURS, OF THE REPTILIAN OR CRAWLING ANIMAL AGE

These water creatures were from ten to forty feet long and had a body like the hull of a submarine, with four great paddles for fore and hind legs.

Meanwhile the cooling water-vapor was becoming water, making oceans and rivers; clouds and rain and cool winds and finally snow and ice became possible on this cooled and shrunken crust; the hardening solids became rocks. The earth ceased to give out heat, and therefore to light itself, but was surrounded by a "small universe of cloud" which shut off sun and everything else. "Darkness was upon the face of the deep," as the Bible story has it. Plant life began, sustained by the heat of the earth within. Then the clouds cleared, the sun was let in, and all was changed. Day was gradually divided from night. "And God said, Let there be lights in the firmament of the heaven to divide the day from the night; and let them be for signs, and for seasons, and for days, and for years. And let them be for lights in the firmament of the heaven, to give light upon the earth; and it was so." Now life, as we know it, could begin; first living creatures, and lastly Man.

This is the wonderful story which the science of to-day tells us of how the world in which we live was made.

THE EARTH OUR DWELLING PLACE

First of all, the earth is our house, where we live. Geography teaches us a good deal about this house. We know its shape and size; how much of it is dry land and how much is covered by water; its valleys and mountains, plains and oceans; where its continents are, and what they are like. Think of the house in which we live. We know its general shape, and whether it is a large or small house; we know how many rooms there are, about how large each room is, and what it is used for. But is that all we know about it? If we are curious, we want to know what the house is made of, how much of it is stone, brick, iron, wood, plaster, or other things; how it was built, where its materials

came from, and how they were made into a house. We are so used to our houses that perhaps we do not think of some of these things, but a cave dweller, who had never seen a house "built with hands," would ask all these and a dozen more questions if he saw our house.

Just so we are used to the earth-house; but when we stop to think, there are all these questions to be asked about it. What is it made of? Is it all of the same stuff? Was it built all at once, or has it been added to or changed, as a house is sometimes made over or given a new bay window? Where did its materials come from? And how were they brought and placed where we find them?

Then we like to know who lived in the house before us. Sometimes a long line of families has lived in it. Perhaps they all died, or some moved and new people came in who had been living in another place. Sometimes they left signs behind them. If we find toys in a room, we know that a family with children has lived in the house.

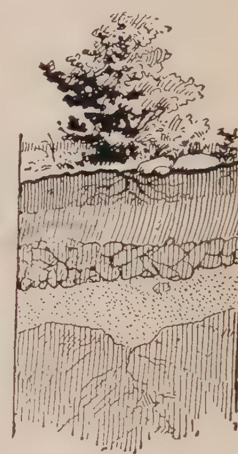
Every one of these things has happened in our earth-house. Animals and plants that lived on the earth in earlier days have left behind them parts of the framework of their bodies; cliff dwellers have left their cooking dishes, warriors their weapons, so that we can find out much about their kinds and ways. And the earth itself has written the story of its own changes on its surface for us to read.

WHAT IS THE EARTH MADE OF?

If you have looked about you, you know that the ground is different in different places. Here we find clean fine *sand* that we can sift through our fingers without soiling them. It is clean even when it is damp. We pat it together into a shape, but it falls apart again. In the country it is yellow, and on the seashore it is nearly white and very fine. There the ground is a great bed of *clay*. If it is dry it feels hard, but it will crumble; and if it is wet it is soft and sticky. We can soften it and make it into whatever shape we like, and when dry it will hold the form we have given it. Both sand and clay, when ground fine, make dust that the wind blows about. In another place there is neither sand nor clay, but rich *soil*, in which plants grow thickly. Where there is good soil people do not let wild things grow, but plant what will be of use to them.

SAND, CLAY, AND SOIL

Mixtures of these three — sand, clay, and soil — make the most of the ground under our feet. People sometimes call it *dirt*, a word which means something else. Its real name is "earth," because it is the material of which the surface of the earth is made. Some places show layers of each kind, with the upper layer of soil, the one next below sand, and the lowest clay — or clay, then soil, then sand.



ROCK STRATA BELOW EARTH'S SURFACE

Sand and clay may be very deep. Good-sized hills may be gravel, which is a coarser sand, or they may be clear clay; but underneath there will be found solid rock. *Rock* or *stone* is the true earth material; the clay and sand and gravel are also made from rock, as we shall see.

So the first chapter in earth's storybook is the story of rock. This chapter is called "Geology," from *Ge*, the Greek word for "earth," and *logos*, "the science of," — the science or study of earth, whose crust is made up of rock.

THE SEA A SOIL MAKER, OR HOW SOIL IS MADE FROM STONE

Go down to the seashore and stand on a cliff during a storm, and you will see how rocks are being made over into gravel or sand. Each huge wave, as it comes tossing and foaming up the beach, lifts up the stones lying there and dashes them against the foot of the cliff. As the green, seething water rushes back again, you can hear the harsh roar of the stones as they grate and grind each other while they are dragged down the beach, only to be caught up and swept once more towards the foot of the

cliff. By this rubbing and grinding against each other their sharp corners are being worn off. Then the round, smooth stones are worn away until they become little pebbles, and finally the particles which make up the soil.

The storms on the seashore do this work on a big scale. Every brook and stream does it in a little way. Wherever water is working on stones, it is wearing them down and rubbing them against each other, making them over into the tiny pieces of matter which make our soil.

HOW GRAVEL, SAND, AND MUD BECOME ROCKS

But if water helps stones to grind each other into soil, it also helps to move sand, gravel, and mud and put them in places where they become rock. If you are in the country, go out after a heavy rain and watch the water running down the road, carrying with it sand, gravel, bits of paper, sticks, and whatever lies in its way. All this matter is carried along with it, so long as the water can flow swiftly. But here is a hollow, which the water must fill. Now it must run more slowly, and it drops the heavier part of its burden. This matter sinks to the bottom of the pool. If the rain lasts long enough, the hollow may be all filled with matter which the water has dropped.

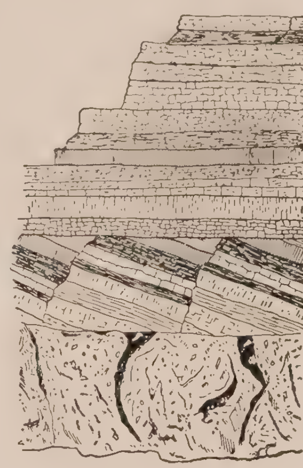
This may seem a very unimportant happening in a tiny pool by the roadside; but it is a small sign of what is taking place all over the world. Wherever there is standing or slow-moving water, the heavier matter in it will sink to the bottom of the course over which the water is flowing. Take a glass of water and leave it standing for a day. Something which we call "sediment" (that which has settled) will sink to the bottom of the glass. When great heaps of soil are dropped by the water and left to harden, they gradually form into rock. Rocks formed in this way have been given two names, — water rocks, because water helped to make them, or *sedimentary* rocks, because they are really hardened sediment.

WHAT THESE ROCKS HAVE TO TELL

There are three great classes or kinds of rocks, and every one has a story to tell. The easiest story to read is that of sedimentary rocks. Their name tells how they were made. Now try putting two or three kinds of material into a glass of water. As they settle to the bottom, you will see that the coarser, heavier particles,

SEDIMENTARY STRATA

the pebbles perhaps, reach the bottom first, and make a heavy layer; then the next lighter settle on top of that, and the still lighter above that, till the water has really sorted all the stuff you dropped in according to its weight, and laid it in layers. This happens if you drop all the stuff in at once. But drop in some sand first, and let it settle; then put in pebbles. Now the water cannot lift the sand and put the pebbles below, even though they are heavier. The pebbles will rest on the sand. If someone came in and looked at that glass of water, he could tell that you dropped the sand in first, and then after it had settled put in the pebbles. The glass of water would tell its own story.



LEVEL STRATA AND FAULTS

Just so mountains and cliffs and cañons, cut in the rock by watercourses, tell their story to us. They are built in layers. Anyone can see that by looking at them. Sometimes the layers are tilted out of the level, as you see, probably by some underground disturbance, like an earthquake; but they are plainly in layers, with lines to show how they run. The layers may be of different kinds of rock, — hardened clay, sandstone, and limestone, all carefully laid one upon the other. Some may be as thin as a piece of paper; some very deep. But they show by these even

COAL FIELDS OF THE LONG AGO. ALL THIS VEGETABLE AND ANIMAL LIFE PERISHED TO MAKE THE COAL THAT IS A WORLD'S FUEL

layers that they were left there by water; and by their age and weight we can tell something of the story of how and when they came there. A queer story it is.

THE STORY OF THE LAYERS

Each layer is a chapter by itself. If we begin with the lowest layer, we shall get the first chapter, which will be thousands of years old. Often it will have signs which will give its place in history.

Suppose at the height of a mountain top we find layers of rock which are plainly made of sand and marine shells, ground up and hardened, but still holding enough of their original form to show they are shells. Sea shells are never found where there is no ocean. So there must have been ocean at this place sometime, which dropped this layer of shells before it shrank away to its present shores. But here, higher than that, is a layer of peat, a marshy vegetable substance, only slightly hardened by the pressure above it. This would show a time when there was a lake and it was gradually choked up into a swamp. High above this, however, is a layer of smooth, well-worn pebbles fitted by a sort of clay into each other and making a whole crosswise slice of the mountain. Water, again we say, for nothing but water or ice could round off the corners of stones to that smoothness. They are like the pebbles at the bottom of a brook. You see, we have quite a story already. Twice, at least, this high mountain of ours has been under water long enough to have a whole layer of rock stuff slowly dropped down. Then it has been a marsh, and between times it has been out of water long enough for each of these layers to harden.

Let us leave our mountain top and go to the bottom of the sea. Here are rocks which we expect to find only above water. They must have been hardened by great heat. Were the ocean beds once empty, and the mountains covered with water?

WHAT ARE FOSSILS?

Layers of rock tell us much by the material of which they were made; but the strange beings imprisoned in them tell even more. In these layers we find what we call "fossils," pieces of rock which look like animals or plants frozen into rock. They are different from the rock in which they are buried. How did they come to be there? Geologists explain them this way: These fossils are the remains of plants or animals which were buried in the earth. They died and dropped into a soft bed of mud or clay, probably on the shores of great bodies of water. The water was drained off, the mud

hardened, but the harder parts of the animal or plant kept their shape and hardened too. If they had been open to light and air, they would have fallen apart and lost all their first shape. But they lay shut away in their beds of mud and did not change except to harden. These fossils are sometimes of plants and animals much like those on earth now, but more often are unlike any which we have ever seen. So they help to tell the story of the earth before we knew anything about it.

FIRE ROCKS AND OTHER KINDS

Before we give the story of the earth as men have read it in layers of rock, we must tell about the other classes of rock besides the sedimentary. These are first the *igneous*, or fire rocks, which have been in a melting state and have grown solid in cooling. The story of how our planet was made shows how many of these there must be. They are named for the Latin word, *ignis*, "fire." Granite is a fire rock; sandstone is a sedimentary rock, made of bits of sand; and chalk belongs to a subdivision of sedimentary rock called *organic* rock, made of the remains of plants and animals, shells and bits of hardened decay of mineral or vegetable matter, ground up and mixed firmly together.

Take a piece of each kind of rock, if you can get hold of it, and look at it carefully through a magnifying glass or a microscope. The granite will look as if it were formed of crystals, thrown and pressed together by some great force, which we know to be heat.

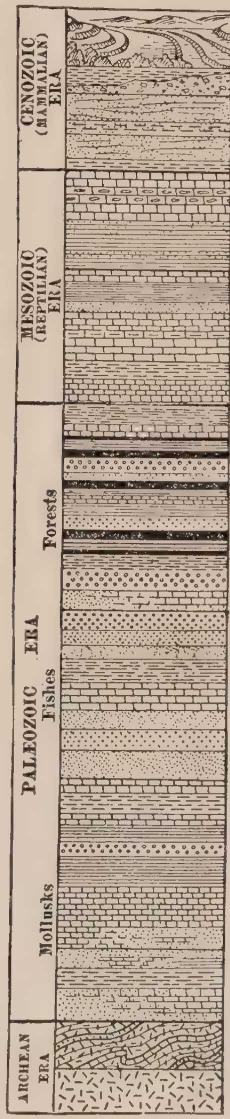
Look next at the sandstone. It appears to be formed of small grains, each one rounded and worn as if rolled in the water. It is made of sand arranged in layers and lines and cemented together. Under the magnifying glass the grains of sand can be plainly seen. By rubbing, the sand can be rubbed out of the stone.

Hold the piece of chalk over a tumbler of water, and brush or rub it till the dust falls and makes the water white and muddy. Let this settle; and then, after pouring the water off, spread some of the soft sediment in the tumbler on a piece of glass and examine it under the microscope. The white powder appears to be composed in part of minute shells and bits of broken shells.

The third class are the *metamorphic* rocks, such as slate, gneiss, and schist. These are rocks that have been changed, or metamorphosed, by great pressure or heat, or both. Thus limestone is changed to marble, sandstone to quartzite.

AGES OF EARTH BUILDING

Mother Earth built her house in layers. That is plain. She used water and fire and air and sunshine to help her place it and harden it. When we find the same layers in many parts of the earth, and the same kinds of fossils in certain layers, we can imagine the order in which she did it, and the tools she used at different times. These periods we call "earth ages." The first age was a rock age, mostly of fire rocks, flowing out from the center of the earth and hardening to make the foundation of our continents and floors of oceans. No forms of life are found in these rocks.



THE FOUR AGES

THE STONE AGE

Then comes the longest age of all, an age with a very long name, which has a very simple meaning. This is the Paleozoic (pay-lee-o-zo′-ic) age, from *palaios*, meaning "very old," and *zoë*, "life." In the first layer there were no fossils. But this age has all sorts of fossils, which are the first signs of the coming of life to our planet. This age was

very long — no one knows how long. Its sediments or layers are twenty-five thousand feet thick in some parts of the world. Mother Earth took a long time building this part of her house. Many of the layers are tilted and tipped, like the waves of the sea, showing great disturbances very deep underground. Most of Europe and North America seems to have been above sea-level. The greater part of the Mississippi Valley seems, so the geologists say, to have been a shallow inland sea, which was to become in the latter part of this long age an immense marsh.

The fossils in the lower layers show life only in its simplest forms, sponges and plant-life. In the higher layers come insects, then fishes, and finally trees and forests, the later decay of which makes our great underground coal-fields. Huge fishes, mosses, ferns, great insects, and snails are some of the signs of life left in the rock layers. With the fishes began one important kind of life, animals with backbones. This age seems to have ended with terrible earthquakes, for the top layers are very much broken and burned with great heat.

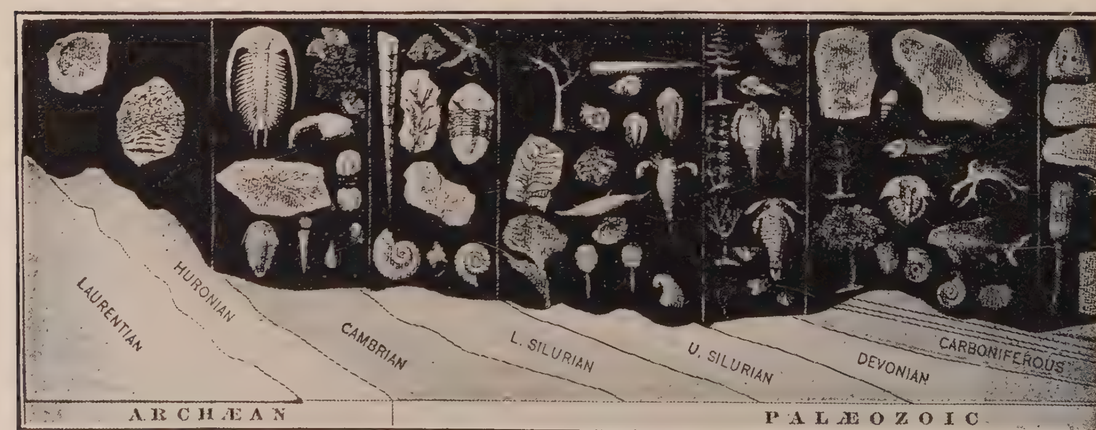
GETTING THE EARTH READY FOR MAN

In the next period, the *Mesozoic*, or middle-life age, both North America and Europe took on their present shape. This was the time of gigantic animals that crawled, — snakes, reptiles of all kinds, huge lizards, some of them from sixty to eighty feet long, fossils of which have been found in these layers. At this time birds also appeared.

Then comes the *Cenozoic*, the recent-life period, which is just before history begins. Mountains were finally formed, lakes and seas were fixed, and the higher forms of animals, the mammals, appeared, such as the elephant, camel, rhinoceros, wolf, deer, and horse. Plants and trees became more like those we know.

All had gone in order up to this time, but now there came a break. North America and Europe were apparently lifted from one thousand to two thousand feet higher than they had been. Then for some reason the ice and snow of the cold north regions crept slowly down till it covered nearly all of Europe and much of the United States. This is known as the *Glacial* age. It was, on a great scale, as if one of the glaciers in our mountain regions traveled down on the valleys below. Everything was covered with ice, and most of the larger mammals perished. The bear, horse, wolf, and reindeer survived; but the greater animals perished. So our animals are all smaller than these wonderful prehistoric animals, the fossils of which we can see in our museums.

Before this period was over, Man must have



This arrangement of life, from its earliest forms, in relation to the geological systems, shows the development of life on the earth, from the beginning to the time when man came. The first life was that of the Eozoön in the Huronian system; next came the fossil trilobites and crustaceans, or lobster family. The Silurian systems have the cuttlefish family, mollusks, starfish, sea-lilies and crustaceans. The sea-lizard and fish come in the Carboniferous system.

been made, for skeletons of cave men are found in the caves with these great animals. Just when Man came into being we do not know, but with the close of the Glacial age begins the age of Man, as we know about him, when Earth had built enough of her house so that it could be his dwelling place.

CHANGES IN THE EARTH'S CRUST

All the changes of which we have spoken happened in prehistoric times; but there are changes which we can see going on now. One of them is what is called "weathering." Whenever any surface, even of what we call solid rock, is exposed to the action of the weather, it is gradually worn away. Heat and cold expand it and contract it, though ever so little; water freezes in its openings and splits them farther apart. Even the air has chemical elements, or acids, which unite with elements in the rocks to change them and wear them away, just as damp air rusts iron, or sulphuric acid eats holes in cloth. Weathering works slowly, but it makes changes. Then there is the work done by water in its various forms,— rivers in their valleys, ocean on its shores, still water and running water. But the most violent changes are those made on the earth's crust from within by earthquakes and volcanoes.

EARTH'S THREE BLANKETS

As our planet has cooled down from a cloud of fire-mist, it has wrapped itself in three coverings, each of them equally necessary to man. The first is the rock blanket of the earth's crust, on the surface of which we live. We can use only about one-fourth of this crust for our dwelling place, because three-fourths of it is wrapped in a water blanket. We can travel across this water blanket in great ships, but we cannot make our homes on it. Still we could not live without this water blanket, for water is needed for every form of life. We could not live on the rock crust or travel on the water, however, if it were not for the great unseen air blanket which surrounds them both, covering the whole globe. This air blanket is two hundred miles high, and perhaps more. It is so thick and so much more like water in its behavior than like rock and soil, that we often speak of it as the ocean of air in which we live, picturing ourselves as walking round on the bottom of this ocean as crabs crawl about at the bottom of our water ocean.

THE OCEAN OF AIR IN WHICH WE LIVE

One of the reasons why people found it hard to believe that the earth was round and was dashing through space at the rate of eighteen

In the Triassic system the mammals first appear; this was the age of reptiles and fishes. The Jurassic and Cretaceous brought the sea-monsters, and the first bird. The Tertiary shows mastodons, and many kinds of extinct mammoths; while the Drift brings the horse, antelope, reindeer, musk-ox, rhinoceros and elephant. In the "River Drift" we find traces of man, and later researches carry him back into the late Tertiary Period.

A TRILOBITE COLONY BURIED IN THE ROCK: THE OLDEST ANIMAL REMAINS ON THE EARTH

miles a second was the stillness of this air ocean. If we were whirling round at this rate, surely there would be a great draught. The air would blow so hard that it would pick us up and toss us off into space. The air certainly would, if it rushed past us. But, as a matter of fact, the air goes with us. If you are inside a railway car with the windows closed, you do not feel the rush of air, because the air in the car travels with you; and it is the same thing on the earth. The air which surrounds the earth clings to it and goes round with it. The force which holds it down is the force of gravitation, pulling the air as it pulls everything else down towards the center of the earth.

The higher we go, the less the pull. This is one reason, though not the only one, why air grows thinner or more "rare," as we say, as we climb a mountain or go up in an aeroplane.

THIN AIR OF MOUNTAINS

Besides the actual pull of the earth drawing the air particles downward, there is the great weight of the whole atmosphere above. Miles and miles of air overhead press mightily downward, packing tightly together the lower layers of air near to earth's surface. If thousands of bales of cotton-wool were piled into an enormous heap, the upper layers might be light and loose in their make, but the lower ones would be squeezed into a very small space by the pressure of the mass above. Without this pressure of the upper air the air down here would not be nearly so dense as it is; and, indeed, would not be fitted to support life. A man ascending a mountain or rising in an aeroplane leaves heavy layers of air below, and has an ever lightening weight above, so that the air around him becomes constantly more thin, more difficult to breathe.

This difficulty is felt severely by those who climb the greater mountains. Within certain limits of height the air is only more light and exhilarating, because a little less dense, than on the plain. But as its rarity increases, the breath gets short, the heart's action is quickened, the sense of oppression grows painful. In the high flights of the aëroplane, the wise aviator takes oxygen to breathe in order to avoid suffocation or heart failure.

Men have, therefore, never been able to measure the depth of the air ocean in which we live. From certain effects of light and heat they can, however, guess at its depth. From the experiences of aviators at the highest points which they have been able to attain, it seems as though man could not breathe much higher.

WHAT IS AIR?

What is air? We talk about it as if it really were something, and yet we cannot see it.

IMAGINARY CROSS SECTION OF THE EARTH

Air is a mixture of gases. All matter appears in three forms,—solids, liquids, and gases. Solids and liquids we can see, but most gases we cannot. It is easy, however, to prove that they are there. Think of the lighting gas which we burn in our houses. If our gas fixture leaks, we do not see gas pouring out, but we can smell it and feel it. No one would ever doubt it was there. We feel air most easily when the wind blows, for wind is only moving air. But even when the wind does not blow you can prove that air is everywhere even if it cannot be seen. Take an empty tumbler and hold it upside down. We call it empty, but it is really full of air — of invisible air. Then take a glass bowl half full of water and float a cork on it. Now gently press the tumbler down over the cork

and see what you will see. If there were nothing in the tumbler, if the tumbler were really empty, then the water would fill it full; but you can see that the water rises only for a certain distance, and no higher. There is air in the tumbler still. Now tip the tumbler sidewise a little, while it is in the bowl, and the air will come out in bubbles.

WHAT WE BREATHE

Of the gases which make up the air mixture, oxygen and nitrogen appear in greatest quantities, with four times as much nitrogen as there is oxygen. But the oxygen, though it is only one-fifth of the air, is a very important part to us, for man and animals require oxygen to breathe. Nitrogen is useful for the building of the bodies of both animals and plants. Farmers use nitrogen fertilizers on their land to give food to plants. Two other gases which appear in air are important. Carbonic acid is the gas formed when coal burns. Plants need this gas in the air to help them to breathe. Water-vapor is the other gas. This water-vapor, that is, water in the form of a gas, forms clouds, rain, snow, and dew. Everything which goes to make up the air mixture is needed, you see, for our life.

AIR HAS WEIGHT

So evenly does air press on everything, that it was a long while before it was discovered that air had weight. Torricelli, a pupil of Galileo, found it out, and the story of this discovery is one of the most romantic chapters in the history of science.

Some gardeners, living in Florence, found that they were unable to pump water to a height of more than thirty-three feet into the air. This was reported to Galileo and Torricelli, and at first they could not understand it. The one thing everybody thought was sure about air was that "Nature abhorred a vacuum." By this was meant that Nature would never leave any space empty that she could fill. This was the principle of pumps. If air was driven out of a space, water would rush in. If water was poured out of a dish, air would rush in. Nature never meant to leave any space vacant, which is our word from the same Latin word, ***vacuum***, which means "empty." When you learn more about Torricelli's work, you will see why this discovery of the gardeners, that water could not be pumped more than thirty-three feet into the air, seemed to go right against this old principle, which, after all, was true, that Nature did dislike or abhor a vacuum.

Torricelli had suspected for some time that air had weight. Now he said to himself, "Air must somehow be able to hold up a column of water thirty-three feet high, but no higher." A column of water thirty-three feet high was a pretty big column to experiment with; so he decided to take something much heavier than water and make his tests with that. Mercury (the silvery-looking liquid we use in thermometers) is one of the heaviest liquids, weighing about thirteen times as much as water. So Torricelli took an amount of mercury which would weigh about the same as this amount of water. If water could be pumped only thirty-three feet high in air, it ought not to be possible to drive a column of mercury more than thirty inches high. He took a long glass tube an inch square, closed at one end, and filled it with mercury. This tube he heated so as to drive out of it any air particles it might have absorbed by standing open to the air. Then he put his finger over the open end of the tube, to hold in the mercury, and turned it upside down in a cup partly filled with mercury. If he had held the tube upside down and simply taken away his finger, the liquid would have run out, would it not? It might be expected even now that it would run out of the tube into the half-filled cup. But it did not. Only a little mercury ran down, leaving a small empty space at the closed top of the tube; but there was still a

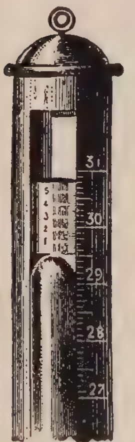
TORRICELLI'S EXPERIMENT

ABOVE AND BELOW THE CLOUDS IN THE WHITE MOUNTAINS OF NEW HAMPSHIRE

column of mercury thirty inches high standing up in the tube. What held it up? The weight of the mercury was pressing down. Yet it did not fall. Something must be balancing that pull down by pressing up. The only thing that could be doing this was the air above the mercury in the dish. This must be keeping it from rising as high as it would if it let all the liquid flow out of the tube into the cup. So the air must be pressing down as hard, that is, be as heavy, as the mercury in the tube. Air must have weight.

HOW MUCH DOES AIR WEIGH?

The next question was how much weight. Again the mercury in the tube could help. It could be weighed. It weighed fifteen pounds. The tube was an inch square. Then the air must be pushing down on that square inch with a weight of fifteen pounds. Nature abhors a vacuum. It would not have left that empty space at the top of the tube if it could have helped it. It was pushing just as hard as it could. But air could press only fifteen pounds to the square inch. It could not hold up any more mercury. It had to leave the space empty.



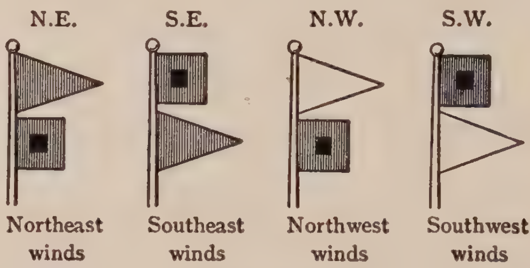
COMMON BAROMETER

For the first time in the world's history air had been weighed. Less heavy liquids were tried, and they stayed higher in the tube; heavier ones did not give so tall a column. But for a square-inch tube the weight held up was always the same. We do not use the word "weight" in speaking of air so much as we do the word "pressure," because weight usually means to us pressing down. Air presses not only down, but up and on every side. If this were not so, we should be crushed by it. Think of a weight of fifteen pounds pushing down on every square inch of your head, with no upward push to balance it. But air pushes in every direction. It is not only above us, but about us; not only outside of us, but inside.

You can prove this in a simple way: Put a piece of paper over the mouth of a bottle full of water. Turn the bottle carefully upside down, and the water will be held in it by the upward pressure of the air on the surface of the paper.

FINDING OUT HOW HIGH A MOUNTAIN IS BY MEANS OF THE AIR

The pressure of air is not always the same. It is different in different places. The mercury tube had been tried at sea-level, and had stood about thirty inches high. Next it was tried on a mountain top. The column was lower. The air was not pressing so heavily; it was lighter. This we can understand very well, for we know there was not so great a mass of air pressing down on it from above, and besides the pull of the earth was not quite so great. The height of the column has been measured for every difference in distance above sea-level. When it had been carried about a thousand feet above sea-level, it was only twenty-nine inches high. Up another thousand feet it had lost another inch.

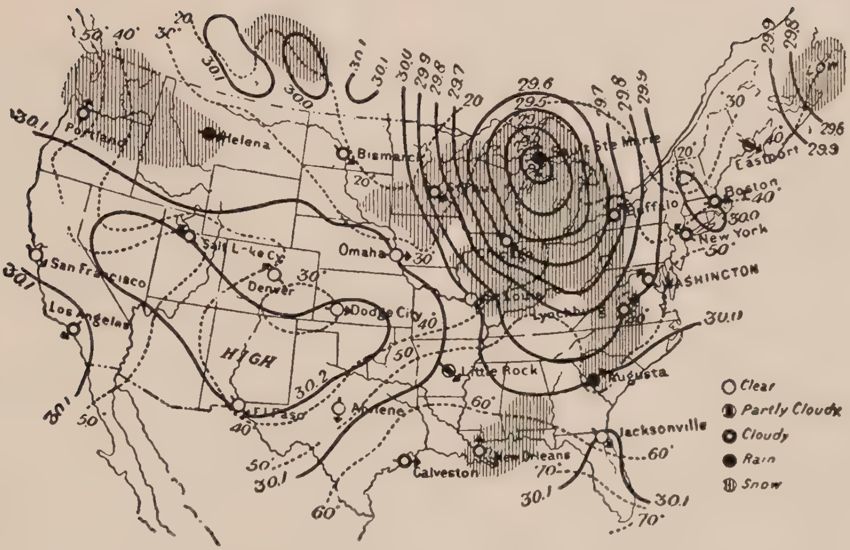


WEATHER SIGNALS

Do you see how this discovery could be turned round to measure the height of mountains? The mercury column measures the weight of the air above you. It falls about an inch for every thousand feet you climb. Then, if your column has fallen about an inch, you have climbed to a point about a thousand feet higher than the one where you read it last. If it falls half an inch, that will mean five hundred feet. This is one way the heights of mountains are roughly measured.

WEATHER PREDICTIONS

Do you know the common name for this mercury tube? A *barometer* — that is to say,



SECTION OF A GOVERNMENT WEATHER MAP, SHOWING THE HIGH AND LOW PRESSURE IN DIFFERENT SECTIONS OF THE UNITED STATES

a weight-measure. Every day when you read the weather prediction in the newspaper, you are reading what this mercury tube has told. In every station of the United States Weather Bureau, and in many private houses, you will see barometers made after just this pattern. They are of use in telling what the weather is going to be, because the weight of air is slightly different with different weathers, as well as at different heights.

WHY THE MERCURY RISES AND DROPS IN THE BAROMETER

In fine weather the mercury in the barometer stands high. The air is heavy and presses it up. In stormy weather it is lighter and the column drops. The reason for this you will understand better when you have read why we have storms. Air-weight changes most with movements in the air caused by heat and cold. Warm air is light, it is put together more loosely than cold; and when a storm is coming, warm air currents are rushing through the air and making it lighter. So the column drops, and we say the barometer is "low." The mercury is very sensitive to air pressure and responds quickly to any slight change. Indeed, it will often find that the air above it is getting light, that is, that a storm is "in the air," before we notice it.

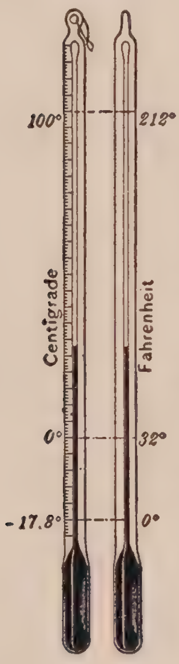
READING THE WEATHER MAP

Look at the government weather map and see how it reads. There will be places where the word *low* is printed; then, in other parts, you see the word *high*. Those are barometer records. Every day, at a hundred places in the United States, in Cuba, and so forth, the observers of the weather bureau notice how their barometers are standing and telegraph to the central weather bureau at Washington. There they make a weather map of the whole country twice every day. If a storm is traveling eastward, it will show on the map by an area of low barometer, as they call it. The barometer in the country round Omaha will be low on Monday, for instance; by Tuesday the storm has traveled to Buffalo; so the weather bureau tells New York to look out for a storm on Wednesday.

THE THERMOMETER

Another mercury instrument, the thermometer, measures the temperature of air for

us. Heat always expands things. It drives apart the particles of which they are made. Mercury is very sensitive to changes of heat or cold. So we use it for our thermometers, our heat measures. A thermometer is a glass tube, closed at both ends, ending below in a glass bulb. It holds enough mercury to fill the bulb and part of the tube, the space above being emptied of air. When the air is hot, mercury feels it very quickly, and swells in size, so that the slender line of it in the tube rises. When the air surrounding the tube is cold, the mercury is chilled. It begins to shrink, and sinks lower in the tube. So we have this simple way of measuring the heat.



THERMOMETER

A German named Fahrenheit invented, about two hundred years ago, the thermometer we use. He put it into melting ice and made a mark on the tube just where the mercury stood, calling this the freezing point; and then into boiling water and made another mark where the mercury stood then. This was boiling point. When you study physics you will find out why he numbered the first mark thirty-two, and the other two hundred and twelve; but he did, and divided the distance between his two fixed marks into one hundred and eighty equal parts, which he called degrees. His thermometer was used in England; the Pilgrims brought it to America; and we use it to-day. But in Europe they use another scale of degrees, which was invented in France about a hundred years ago. Ours is the Fahrenheit thermometer, named for the man who invented it. Theirs is the centigrade, from the Latin word *centum* for "one hundred," and *gradum* for "degree." It is so named because it has one hundred degrees, freezing point being at zero, and boiling point at one hundred. Of course you will pronounce the name Fah-ren-*hite*, not Fah-ren-*heat*.

HOW AIR GIVES OUT WATER

There are two questions we ask about the weather. The first is, "Is it warm or cold?" the second, "Is it wet or dry?" It does not take a very wise person to know that there is often water in the air. As a matter of fact, there is always water in the air. But how does it get in and out? Bring a tumbler of ice-cold water into a warm room, and watch what happens. The outside of the glass will soon be covered with a fine film of mist. In a little while tiny drops of water will form out of this film, and will go on growing, until perhaps some of them unite and trickle down the sides of the tumbler.

You may have noticed, too, that on very cold nights the windows of sitting-rooms or crowded public halls are found streaming with water on the inside.

Where does this moisture come from? It certainly does n't come out of the glass. It comes from the water-vapor in the air. By vapor we must always understand some kind of visible mist or fog or cloud. When the invisible vapor dissolved in the air becomes visible, as in mists, clouds, dew, or rain, it has been *condensed;* that is, pressure has pushed the particles of which it is made closer together. Condensed milk is milk which has been changed to the thickness of very heavy cream. Liquids are thicker, more dense, than gases; so a gas must always be condensed to become a liquid. The film of mist which forms on the tumbler is really dew, just such as we see at night and morning upon grass, leaves, stones, or anything which is left open to the night air. After the sun has set, the grass is cooler, and the air gives it some of its water.

HOW AIR TAKES UP WATER-VAPOR

We need only to think of our own weather, with its damp days and dry days, to know that the amount of water-vapor in the air is always changing. It varies with the temperature. Warm air can hold more than cold. You can show this in a simple way. In breathing, you give out at each breath a quantity of water-vapor; when the air is warm, this invisible vapor, as soon as it escapes from you, mixes

with the outer air, and is kept dissolved there. But if you cool the breath as it leaves your mouth, the vapor becomes visible moisture. Take a mirror, for example, or any other cold surface, and breathe on it; the vapor from your lungs at once shows itself in a film of mist upon the glass, because the air touching the cold surface is chilled and cannot hold so much vapor, part of which is condensed. In winter the cold air around you at once condenses this vapor as it comes from the mouth, and forms the fine cloud or mist which appears with each breath you give out.

As air cools, its power to hold vapor grows less, and it gives out what it cannot keep in moisture. Then it grows warmer again, or for some other reason does not have all the vapor which it can hold. How does it get it back? It draws it out of the water again. If you pour a little water into a plate, and set it down in the open air, you will notice, in the course of a day or two, that there is less water in the dish than when you set it out. The air has drunk up part of it, and will drink up the whole if the water is allowed to stand long enough. We say that the water has *evaporated*, that is, passed off into vapor. Earth and air are both dependent upon water.

AIR A GREAT WATER DRINKER

Air wants as much water as it can hold, so on a dry, bracing day water will evaporate very fast, because the air wants it and has room for it. On a damp day, however, when the air has about as much vapor as it can hold, evaporation is quite feeble or stops altogether. That is why housekeepers find so much difference between days, in the ease with which they can have their clothes dried. On some days the air is busy drinking up vapor everywhere, and then the clothes dry quickly. Such is especially the case when the sky is clear and the wind blows, because every moment a fresh quantity of air comes in contact with the clothes, carries off some of the vapor, and passes on to make way for fresh supplies of thirsty air. On other days, the air can hardly hold more vapor, and the clothes are found at the end of the day to be almost as wet as when they were hung out in the morning.

CRYSTAL ETCHINGS BY JACK FROST

STORM CLOUDS

CUMULUS CLOUDS

HOW CLOUDS ARE MADE

This taking up and giving out of moisture by our air blanket is the explanation of clouds. Clouds are water-vapor cooled into liquid form. Sometimes they are a thin mist. When vapor condensed on the outside of the glass in the warm room, it did not at once become running water. There was a fine mist on the glass before the drops of water appeared. This mist was made up of tiny particles of water which ran together to make drops. When a warm, moist cloud blows over a cold mountain top, there is not instantly a shower of rain. Yet the air is cooled, so that it must give out some of its vapor. This becomes a mist, which seems often to rise from the ground, and which shapes itself to the form of the ground, as if it were a sort of fleecy cap drawn down over the mountain's head. Mountains are often covered with a mist cap in the morning. As day advances, the ground, warmed by the sun, no longer cools the air. The air can drink up the mist, and the mountain is clear. Then as night comes on the ground grows colder, and the mountain pulls on its mist cap again.

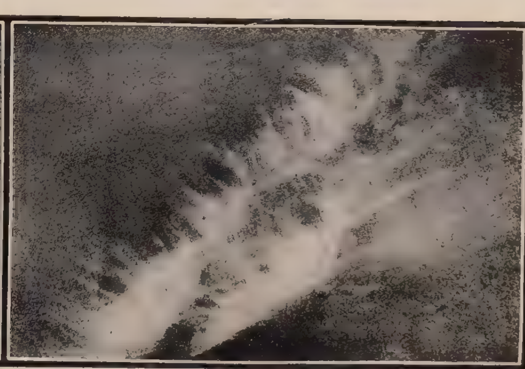
Cold air, as well as cold ground, condenses warmer air into vapor. If you watch what goes on in the sky, you may often see clouds in the act of forming. At first a little flake of white appears. By degrees this grows larger and other cloudlets arise and flock together, until at last the sky is quite overcast with heavy clouds. On a summer morning the sky is often free from clouds. As the day advances, and the earth gets warmed, more vapor is raised; and as this vapor reaches the higher and colder parts of the atmosphere, it is chilled into the white, fleecy clouds which you see forming about midday and in the afternoon. Towards evening, when less evaporation takes place, the clouds cease to grow, and gradually become smaller until at night the sky is quite clear. They have been dissolved again by descending and coming in contact with the warm air nearest to the earth. Again, you have often noticed that clouds move across the sky. They are driven along by upper currents of air, and of course the stronger these currents are the faster the clouds travel. In this way the sky is sometimes completely overcast with clouds which have come from a distance.

This is the story of a cloud as the scientist tells it. Now see how the poet Shelley has taken this same story and woven it into a beautiful poem of what a cloud might say. Notice how true to fact and yet how full of imagination each stanza is. This is one of the most perfect poems in our language.

THE CLOUD

I bring fresh showers for the thirsting flowers,
  From the seas and the streams;
I bear light shade for the leaves when laid
  In their noon-day dreams.
From my wings are shaken the dews that waken
  The sweet buds every one,
When rocked to rest on their mother's breast,
  As she dances about the sun.
I wield the flail of the lashing hail,
  And whiten the green plains under,
And then again I dissolve it in rain,
  And laugh as I pass in thunder.

STRATUS CLOUDS



CIRRUS CLOUDS

I sift the snow on the mountains below,
  And their great pines groan aghast;
And all the night 't is my pillow white,
  While I sleep in the arms of the blast.
Sublime on the towers of my skiey bowers,
  Lightning my pilot sits;
In a cavern under is fettered the thunder, —
  It struggles and howls at fits;
Over earth and ocean, with gentle motion,
  This pilot is guiding me,
Lured by the love of the genii that move
  In the depths of the purple sea;
Over the rills, and the crags, and the hills,
  Over the lakes and the plains,
Wherever he dream, under mountain or stream,
  The Spirit he loves remains;
And I all the while bask in heaven's blue smile,
  Whilst he is dissolving in rains.

The sanguine sunrise, with his meteor eyes,
  And his burning plumes outspread,
Leaps on the back of my sailing rack,
  When the morning star shines dead,
As on the jag of a mountain crag,
  When an earthquake rocks and swings,
An eagle alit one moment may sit
  In the light of its golden wings.
And when sunset may breathe, from the lit sea beneath,
  Its ardors of rest and of love,
And the crimson pall of eve may fall
  From the depth of heaven above,
With wings folded I rest, on mine airy nest,
  As still as a brooding dove.

That orbèd maiden with white fire laden,
  Whom mortals call the moon,
Glides glimmering o'er my fleece-like floor,
  By the midnight breezes strewn;
And wherever the beat of her unseen feet,
  Which only the angels hear,
May have broken the woof of my tent's thin roof,
  The stars peep behind her and peer;
And I laugh to see them whirl and flee,
  Like a swarm of golden bees,
When I widen the rent in my wind-built tent —
  Till the calm rivers, lakes and seas,
Like strips of the sky fallen through me on high,
  Are each paved with the moon and these.

I bind the sun's throne with a burning zone,
  And the moon's with a girdle of pearl;
The volcanoes are dim, and the stars reel and swim,
  When the whirlwinds my banner unfurl.
From cape to cape, with a bridge-like shape,
  Over a torrent sea,
Sunbeam-proof, I hang like a roof,
  The mountains its columns be.
The triumphal arch through which I march
  With hurricane, fire, and snow,
When the powers of the air are chained to my chair,
  Is the million-colored bow;
The sphere-fire above its soft colors wove,
  While the moist earth was laughing below.

I am the daughter of earth and water,
  And the nursling of the sky;
I pass through the pores of the ocean and shores;
  I change, but I cannot die.
For after the rain when, with never a strain,
  The pavilion of heaven is bare,
And the winds and sunbeams with their convex gleams
  Build up the blue dome of air,
I silently laugh at my own cenotaph,
  And out of the caverns of rain,
Like a child from the womb, like a ghost from the tomb,
  I arise and unbuild it again.

CLOUDS AND THEIR HEIGHTS

Watch the sky and you will soon be able to recognize several kinds of clouds. Highest of all are the *cirrus* clouds, named from the

Latin word for a curl of hair, because they are thin, feathery, curling wisps of white vapor. They are often five or six miles up in the air. Next below them are the *cumulus* (Latin for "heap") clouds, great, rounded, billowy masses, looking like mountains in the sky. They are formed by the rising of warm air from the earth, and are usually from half a mile to two miles up. Cumulus clouds often develop into storm clouds, which are also called *nimbus* clouds. Low in the sky, especially in stormy weather, you will see the *stratus* clouds, lying in layers across the horizon. When they are so very low that we are walking around in them, we call them fog.

RAIN AND SNOW

When clouds condense from fine mist into big drops of water, which are too heavy for the air to hold up, we have rain. Sometimes in cold weather we have snow instead of rain.

Snow is not frozen rain. It falls directly as snow from snow-clouds. In winter the frozen clouds lie at a much lower level than in summer. Snow-clouds, like mist-clouds, when they grow too heavy, have to part with some of their substance, which falls to the earth in white flakes instead of water-drops. Much more than mere weight, however, is involved in a fall of snow.

WHY SNOW IS BEAUTIFUL

Snowflakes are made of the most exquisite ice crystals. The minute needles group themselves into beautiful star-like shapes, always six-pointed. Many substances, when changed from a liquid into a solid, will crystallize into delicate and beautiful forms, and it is notably so with water. When sometimes water vapor freezes into snow, the snow crystals are always formed of six-pointed stars or plates. That it is so we can see with the microscope; but why it should be so we do not know. If very large flakes come down, they are caused by the union of smaller flakes. The drier the air, the smaller and harder will the flakes be, for they cannot stick together unless they are a little damp. A handful of snow brought indoors soon melts into water, which, on further exposure to the air, evaporates.

HAIL, SLEET, AND ICE

Besides rain and snow, the moisture of the air takes sometimes the form of hail, which consists of little lumps of ice, like frozen rain, and of sleet, which is partially melted snow.

On a frosty night pools of water are covered with a hard, transparent crust, which we call ice. Brought into a warm room, it soon melts into water, which may easily be turned by quick heating into steam or water-vapor that we can see, but is quickly absorbed by the air of the room. So rain, snow, ice, hail, sleet, mist, and steam are the liquid, solid, and gas forms of this one substance whose common form is water.

WHAT WE OWE TO AIR AND WATER

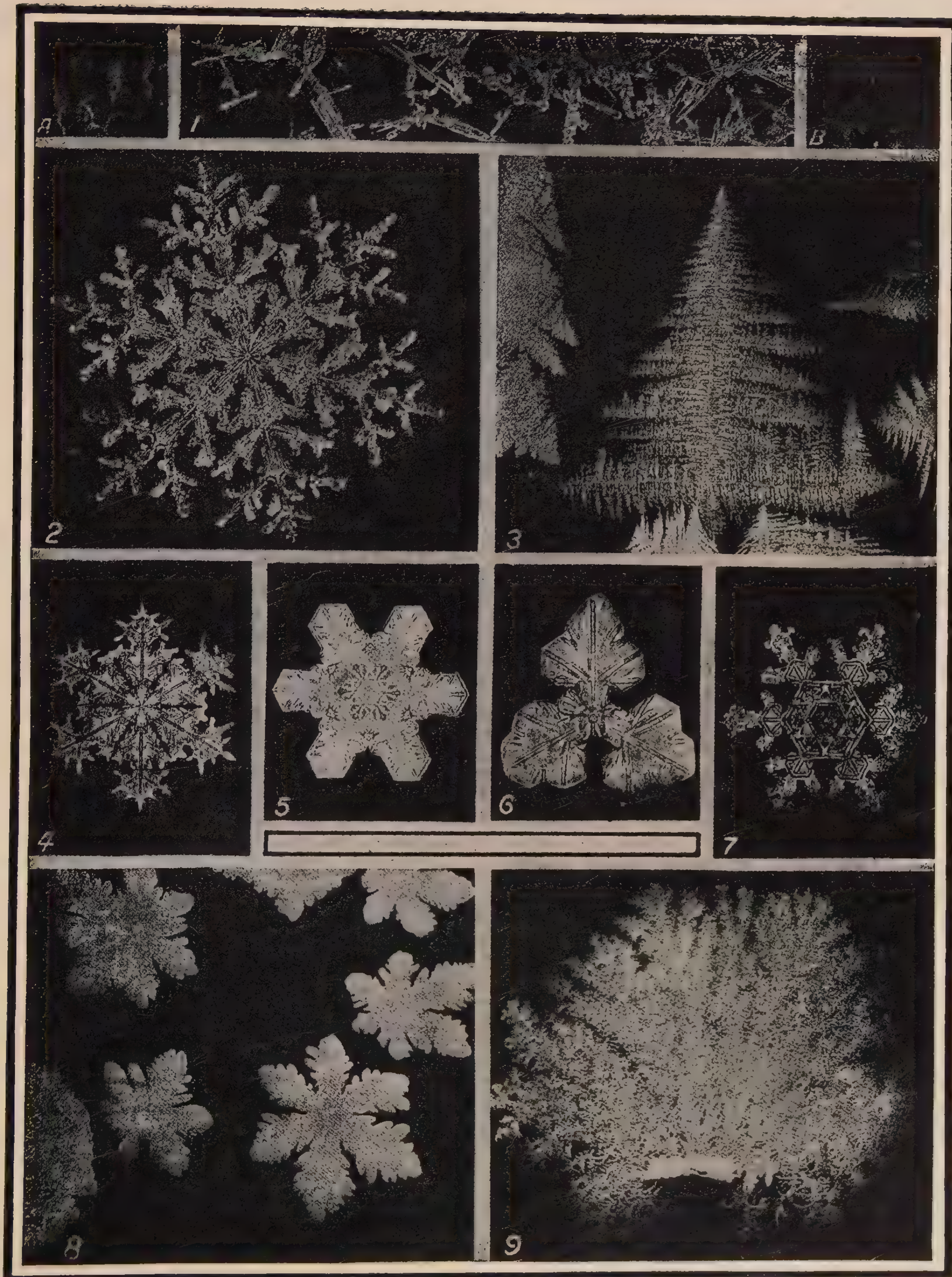
This exchange of water between earth and air is one of the best things in the world for us. It is really necessary in order to make the earth a fit dwelling place for man. Just as the circulation of the blood keeps our bodies alive, so this circulation of the air keeps life on earth. It mixes and washes the air, clearing away impurities, such as those which rise from the chimneys of a town. It moistens and quickens the soil, so that trees and plants and flowers can grow from it. It supplies springs, brooks, and rivers. In short, it is the very mainspring of all the life of our earth.

A PERSIAN STORY OF HOW THE GODS MAKE RAIN

The Persians have an old story telling how rain was produced by Tistrya, the leader of the stars, which belong to Ahura Mazda, the supreme god. Tistrya is Sirius, the chief summer star, who appears in June and July. He has a great struggle with Apaosha, the demon of Drought. At first it looks as if Apaosha would win, but Tistrya conquers at last.

The story represents Ahura Mazda talking to mankind. He says:

"We worship the lordship and mastership of Tistrya, whereby he protects the moon, the dwelling, the food, when my glorious stars come along and impart their gifts to men. I will sacrifice unto the star Tistrya, that gives the fields their share of the waters.



SNOW CRYSTALS, IN THEIR VARIED AND EXQUISITE FORMS

A and B. Ice crystals. 1. Sleet, sharp and stinging. 2. A diamond pendant. 3. Frost design "from the land of the pointed firs." 4, 5, 6, 7. Snow crystals. 8. Snow leaves. 9. Hoar frost.

"We sacrifice unto Tistrya, the bright and glorious star, who flies toward the sea as swiftly as the arrow darted through the heavenly space. We sacrifice to Tistrya, the bright and glorious star, who, in the shape of worm-stars, flies between the earth and the heavens, in the sea, the powerful sea, the large-sized deep sea of salt waters. He goes to its lake in the shape of a horse, and down there he makes the water boil over, and the winds blow most powerfully all round. Tistrya spake unto me, saying:

"'If men would worship me with a sacrifice as they worship other stars with sacrifices, then I should have come to the faithful at the appointed time of my beautiful, immortal life, should it be one night, or two nights, or fifty, or a hundred nights.'

"We sacrifice unto Tistrya; we sacrifice unto the rains of Tistrya, the first star.

"For ten nights, O Man! Tistrya, the bright and glorious star, mingles his shape with light, moving in the shape of a man of fifteen years of age, bright with clear eyes, tall, full of strength, strong, and clever.

"Here he calls for people to assemble, here he asks, saying: 'Who will now offer me worship? Now I ought to receive sacrifice and prayer in the world.'

"The next ten nights, O Man! the bright and glorious Tistrya mingles his shape with light, moving in the shape of a golden-horned bull. For the next ten nights, O Man! the bright and glorious Tistrya mingles his shape with light, moving in the shape of a white, beautiful horse, with golden ears and a golden harness.

"But there rushes down to meet him the demon Apaosha, in the shape of a dark horse, black with black ears, black with a black back, black with a black tail, stamped with brands of terror.

"They meet together hoof against hoof, O Man! the bright and glorious Tistrya and the demon Apaosha. They fight together, O Man! for three days and three nights. And then the demon Apaosha proves stronger than the bright and glorious Tistrya; he overcomes him.

"And Tistrya flees from the sea as far as a mile's length. He cries out in woe and distress, the bright and glorious Tistrya:

"'Woe is me, O Ahura Mazda! I am in distress, O waters and plants! Men do not worship me as they worship the other stars with sacrifices. If men had worshiped me with a sacrifice as they worship other stars, I should have taken to me the strength of ten horses, the strength of ten camels, the strength of ten bulls, the strength of ten mountains, the strength of ten rivers.'

"Then I, Ahura Mazda, offer up to the bright and glorious Tistrya a sacrifice in which I bring him the strength of ten horses, the strength of ten camels, the strength of ten bulls, the strength of ten mountains, the strength of ten rivers.

"Then, O Man! the bright and glorious Tistrya goes down to the sea in the shape of a white, beautiful horse, with golden ears and a golden harness.

"But there rushes down to meet him the demon Apaosha in the shape of a dark horse, black with black ears, black with a black back, black with a black tail, stamped with brands of terror.

"They meet together, hoof against hoof, O Man! the bright and glorious Tistrya and the demon Apaosha; they fight together, O Man! till the time of noon. Then the bright and glorious Tistrya proves stronger than the demon Apaosha; he overcomes him.

"Then he goes from the sea a mile's length, and cries:

"'Hail unto me, O Ahura Mazda! Hail unto you, O waters and plants! Hail will it be unto you, O lands! The life of the waters will flow down unrestrained to the big-seeded cornfields, to the small-seeded pasture-fields, and to the whole of the world!'

"Then he makes the sea to boil up and down; he makes the sea to stream this and that way; and vapors rise up above the mountain that stands in the middle of the sea. Then the vapors push forward, in the regular shape of clouds; they go following the wind, along the ways which Haoma, the increaser of the world, travels. Behind him travels the mighty wind, made by Mazda, and the rain and the cloud, and the sleet, down to the several places, down to the fields, over all the earth."

WHY DOES THE WIND BLOW?

The air in which we live is never at rest. Streams of air flow hither and thither, making

winds from the north and east, winds from the west and south, winds from every point between. Some change from hour to hour. Others flow in the same direction for months. Some are hundreds of miles wide. Others may be measured by yards. There are great rivers, as well as tiny brooks, of moving air in this air ocean; and wind is nothing more nor less than moving air.

But why should air move at all? We can picture to ourselves a great ocean of air in perpetual repose, a world without winds, an atmosphere without movement. Such a world with such a blanket of air might possibly exist under certain conditions; but it would have to be very different from ours, a world not spinning upon its axis day and night, a world without varieties of heat and cold, of climate and weather.

Wind is caused by change in temperature. When any part of the earth's surface becomes heated more than other parts near it, the air over that part gets warmer too. But when air is heated it expands; its particles get farther apart, it spreads out, and so becomes less heavy. Then it rises, pushing the air over it away. At the same time the colder, denser air from the cooler parts of the earth rushes in to take its place. This is the way winds begin. They are named, as you know, from the direction in which they come. Because the northern part of the world is usually colder, a north wind will probably be cold, and wind from the south will be warm. It all depends, not as we think on what part of the sky they come from, but what temperature of earth they have had under them, and how much water-vapor they have picked up.

WORLD WINDS

The geographies tell us about the north and south poles, and about the equator, that line which we imagine running round the earth halfway between the poles. You have also heard about the zones or belts of heat and warmth which run round the globe. But what you have read of the movements of earth and sun will make you understand more about the reasons for these zones. The belt right round the equator gets the rays straight from the sun; so it is hot. The temperate zones get them more or less slanted, and for greater or less lengths of time; so they have warm summers and cold winters. In the northern zones the sun shines low in the sky part of the year, making this region very cold.

These things are familiar to us; but the question is how they affect the winds of the world, which we have found to depend on the heat or cold of the ground beneath them. They make great world winds which blow in the same general direction all the time. The warm earth

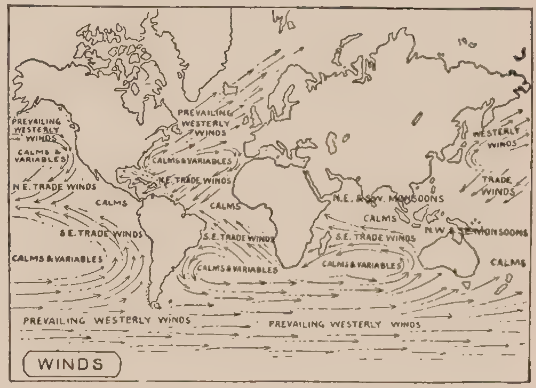


CHART SHOWING THE WORLD WINDS

round the equator makes a belt of warm air encircling the earth for a wide space. This air is light and rises, flowing naturally in a very high stream or current towards the poles, but being chilled and condensed as it travels along. Meanwhile the cold air rushes in from the cooler regions to the north and south. These surface winds flowing in towards the hot countries are the trade winds. Right at the equator where the opposite kinds of winds meet — one low current of cold air rushing in and the other high current of warm air rushing out — there is a still belt, which has long calms and much rain. The air currents are fighting with each other. This belt of "equatorial calm" used to be very much dreaded by sailing vessels, which depended on the wind to carry them and would sometimes have to wait weeks for a breeze. But right above and below this belt were the belts of the trade winds, so named because they helped the world's trade when it was carried on by sailing vessels. These winds blowing in from the poles toward the equator

could always be counted on to give the vessel a lift.

There are other great wind belts, but these are the most important. They are not always at just the same place on the globe, and they do not blow straight from north or south.

ROCKS THAT STORE WATER

Can you think why that is? The movement of the earth. We are always being brought back to that, until we begin to see what a difference this one fact makes in our understanding of things which take place on the earth. If the earth stood right up and down, the currents would blow due north and south. Now they are shifted by the spinning motion of the earth, and by the speed at which it turns in different places, so that they blow to the northeast or to the southwest.

These are not all the wind movements. Upper currents drop to the surface, and surface currents rise many times in the long journey of these world winds. But it all goes to show how the spinning earth pulls its air blanket round with it, and how the air blanket tries to fit itself to the earth.

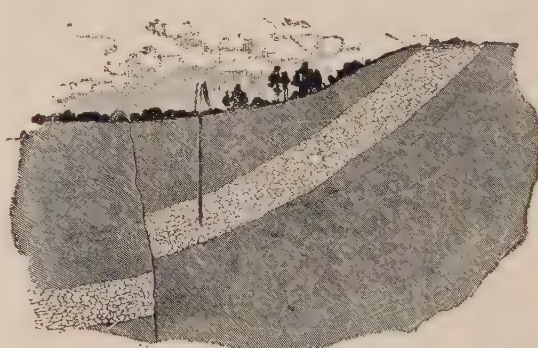
When all has been said, no words sum up the story of winds better than this sentence from the Bible:

"The wind goeth towards the south, and turneth about unto the north; it whirleth about continually, and the wind returneth again according to his circuits."

WHAT BECOMES OF RAIN

Just as water is always being passed from air to earth and back again, so it is passed from one part of the earth's crust to another. The ground needs a good deal of rain to keep it moist. But it cannot always take it up as fast as it falls. Then we have floods in our rivers and deep mud in our roads. But in a few days these disappear. The ground has taken the water and stored it away. Some kinds of soil let water through easily. They are loosely put together. A bed of sand will dry off very quickly. It has let all the water run through. But clay is very closely made and will hold water a long time. In regions where the soil is of a kind to hold water well, there will be many springs near the surface, ready to bubble out when they find an opening. In others we have to dig wells deep down into the earth to reach the great underground water supply which the rocks are holding in their basin.

This underground water supply helps also to keep the rivers full. Away up in the mountains there will be two or three springs. Water will flow from them down the mountain side, wearing a place for itself as a tiny stream. Then it will meet other streams. Other springs



WATER FORCED UP THROUGH A ROCK FAULT, AND DRAWN UP BY AN ARTESIAN WELL

will flow into it, and down on the lower lands there will come to be a great, wide river, fed by many streams. The earth has given out the water which came down in rain and was stored.

THE GORNER GLACIER IN THE SWISS ALPS

Air will pick up some of it and give it back, and so the circle will begin again.

GLACIERS AND ICEBERGS

Rain flows down from the mountains in rivers, but what about the snow? How do the mountains get rid of the extra loads which every winter puts on their backs? Below the freezing line, where it is warm enough for snow to be melted into water, it too can be taken care of by rivers and springs. But above the freezing line, where snow never melts except the tiny layer which is right on the surface and catches the rays of the sun, this extra amount must be taken care of in some other way. Then we have glaciers, rivers of ice, pushing slowly down the mountain side into the valley. As it travels down it loses much of its surface by melting, but the central part stays frozen for months and years, creeping inch by inch down the valley. When an ice river starts from the cold north, and reaches the sea, it breaks up into icebergs, which float off to the south.

HOW DO WE KNOW THAT THE EARTH IS ROUND?

If a friend asked you to tell how you knew that the earth was round, what would you say? You know it is. You have always been taught so. You have seen globes showing just how it looks. You even know that people go round it. But if anybody came to you and insisted that the earth was a flat plain and said you had been taught wrong, how could you prove you were right?

If you were by the seashore, or by a great lake, you would take him out and ask him to watch a ship as it came in sight at the edge of the horizon and then gradually approached you. If the earth were flat, as soon as the ship appeared on the horizon, you would see the whole of it. But you see the topmasts first, or, if it is a steamer, you see the top of the smoke-stack with the smoke pouring from it. Then, as it comes nearer, you see the sails and the upper decks, and then at last the hull of the ship comes into sight. This is what happens if you look at something coming up over the top of a hill or any curved surface. Then, too, the ship

SHIPS SHOWING A ROUND EARTH

always looks like this when it is coming towards us, no matter whether it comes from north or

south, east or west. So we judge that the earth does not bulge out in only one place, but that it is evenly curved, or round.

If you lived where there was no great body of water, you would have to prove your point by the horizon line. It is because of the roundness of the earth that our outlook on a plain is so soon shut off by this line, which looks as if it were the meeting of earth and sky. If the earth were flat, we should be able to see much farther. Again, this horizon line is a circle. This is not absolute proof that the earth is round, for if you happened to be standing in the center of the great flat plain which men used to think was the earth, you would have a circle for the horizon line. But suppose you went off to the edges of the world. Then the line ought to be uneven. Our horizon line is a circle at any place on the earth's surface. So the earth must be round.

THE LAND AND WATER DISTRIBUTION OVER THE TWO HEMISPHERES

HOW DO WE KNOW THAT THE EARTH IS NOT PERFECTLY ROUND?

Yet you must remember to tell your friend that the earth is not perfectly round; it is not a true sphere, like a ball; and how do we prove that? We can guess it easily enough by the roughnesses of the earth's crust, the mountains and valleys and sea basins; but we can prove it by carrying something from the equator to the north or south pole, or as near as we can get, and weighing it in each place. At the poles it will weigh a little more than at the equator. The poles must then be nearer the center of the earth where the pull of gravity begins. As a matter of fact it has been proved that the earth is slightly flattened at the poles, as though you took a rubber ball and pressed it gently on two opposite sides.

LAND AND WATER

How queer it would be if the land and water were equally scattered over the globe! We should have to spend much more of our time traveling on the water than we do, for the land part is only one-fourth of the water part. If this land part were scattered equally over the water surface, we should all be living on tiny islands in the midst of great stretches of water. But fortunately the land is grouped into great sections which we call continents, and the waters are massed into seas. The sea runs up into the continents in great gulfs, and the land reaches out into the sea in capes or separate islands; but on the whole the land is crowded together, and the water together. The queer part of it is that the land is almost all pushed up to the top of the globe, crowding towards the north pole in an irregular kind of ring, so that nearly all the land is collected in one hemisphere and nearly all the water in the other. Why this is so we do not know, though men have given all sorts of reasons. Some say it is because of the tip of the earth; the water is lighter and the sun and moon can pull it easier than they can the land. Others think it is because the cooling took place in a certain fashion, making the great ocean beds towards the south, because there was more cold there, and so more shrinking. It is an interesting fact that the bottom of the ocean in its deepest parts is from five to six miles below the sea-level, while the highest mountains in the world are about the same height above sea-level.

THE SCIENTIFIC NAME FOR MOTHER EARTH'S DIARY

Now would you like to know the name that students give to this story of the earth crust and its air and water blankets about which you have been reading? They call it "physiography"; and what does that mean? *Physio* is from the Greek word for "Nature," and *graphy* means "writing"; *physiography*, "Nature's writing," the diary which Mother Earth has kept and written on her surface for us to read.

AIR AND ETHER MESSAGES

MESSAGES WHICH AIR BRINGS US

AIR is man's most faithful and devoted messenger. It is only lately that he has begun to understand to how many uses he can put air — sending wireless messages by it, and the like; but air has not waited for man's slow finding out of each of its uses. It has been bringing him certain messages ever since the beginning of the world. Sound is one of them. The world would be absolutely still if it were not for air to bring the messages of sound to our ears. Light and heat are two other messages. Some kinds of light and heat could come to us anyway without air; but they would be very different and very much less pleasant if air did not take them into its kindly keeping for a time and bring them to us in just the way we can bear them. So we cannot close our story of earth without giving a little time to these wonderful messages which air brings to us earth dwellers. Of course, if it were not for air we should not be able to live on the earth at all; so that our debt to air begins with life itself.

After reading as far as we have in the books of the heavens and the earth, we hardly need to be told that there are two main sources of heat in the world: the sun and the inside of the earth. There are other ways in which heat is made than by the sun and the earth. We can make heat by rubbing two hard substances together, or by putting certain liquids or gases together. These are the ways the sun and earth make their heat, by friction, or shrinking, or by some sort of chemical action. We make heat in our bodies — what we call animal heat — by eating food which will start chemical action. But most of our heat comes from the sun, and all the heat that comes from the sun is brought to us by the air, which both serves and shields us.

IDEAL TERRACE, YELLOWSTONE NATIONAL PARK

HOW HEAT IS GIVEN OUT

How does the sun seem to give out heat and light? By rays, does it not? We talk about the sun's rays as being very bright or very hot, and we go into our houses and put a roof between ourselves and these rays when we want to keep cool. Because heat and light are given out from hot or burning bodies in what we call "rays," that is, lines coming out from a surface in all directions, we say that heat and light come to us by *radiation*, that is, the giving out of rays. Notice the word, for you will meet it often. We have heat radiation and light radiation, and scientists are beginning to think that there are many other kinds of which they have not known. They are wondering if radiation will not prove to be one of the strongest forces working against gravitation, so that while gravitation is trying to hold things together and pull them towards a center, this great opposite force is also hard at work, sending out rays not only of light and heat, but many other kinds of which we do not know because we cannot see or feel them.

WHAT AIR DOES WITH THE SUN'S RAYS

We can imagine the sun's rays traveling along through space towards the earth until all at once they strike the thin upper layer of our one-or-two-hundred-mile-thick air blanket. What will happen then? What happens always when something comes between the object that is giving out heat and the object that is receiving it? Try for yourself with a fire. You sit before an open fire and the heat pours out from the coals until your face begins to burn. You are getting the rays of heat too directly for your comfort. What do you do? You put something between you and the fire. Either you hold up a screen before your face, or you move to the other side of the room; that is to say, you put more air between you and the fire. The air takes up some of the heat, so you do not get as much.

This is one of the great services air does us. It takes up some of the heat of the sun's rays as they come through it, and keeps them from beating down on us with the terrible scorching force they would have if they came straight without passing through any air blanket. Do you remember that we found that the moon is a dead world, its surface all scorched and burned to dead dryness? That was partly because the moon has no thick air blanket to shield it. The sun's heat could get right at the surface and burn it.

The farther you are from a fire, the less heat you feel from it, because you have more air between you and the fire. So the amount of heat depends partly, at least, on the amount of air the heat has to pass through before it reaches us. Do we always have just the same thickness of air blanket between us and the sun? No, we do not, and that is why we have different climates in different parts of the world; but before we talk about the reason for climates, let us find out what climate is.

WHAT IS CLIMATE?

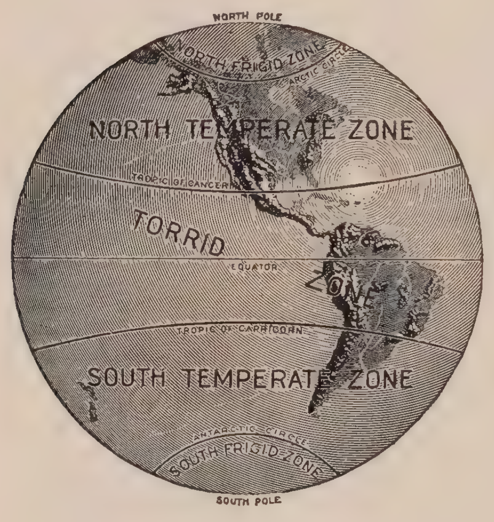
If you were a long way from home and someone asked you what kind of climate you had in the place where you lived, what sort of things would you tell him about? You would probably begin by saying that it was a very good climate, for that is the way most people feel about the climate in which they were born and brought up and to which they are accustomed. Then, if he wanted to know what made it good, you would have to tell him about the weather you had, whether it was very hot, how low the thermometer ever went, whether you had snow in winter, if there was a great deal of rain, and if it came scattered along through the whole year or all at once in one or two wet seasons with long dry times between. To tell him about your climate, then, you would have to describe the weather. But is climate weather? Yes, only it is not "one weather," not the weather of one day or one week or season, but all the weathers put together, the combination of weather changes which happen in a year and repeat themselves from year to year.

The weather in a place varies from day to day. The climate is usually much the same from year to year. This makes one big difference, so far as man is concerned, between climate and weather. A man need not travel to change his weather. He has but to stay at home and

GRAND CAÑON OF THE YELLOWSTONE, AND LAKE MINNEWONKA, IN THE NATIONAL PARK

Mountains and lakes hold water and so cool the air, making climates favorable for man.

go about his daily work. As the seasons roll on, all the usual changes of weather will come, and he will have no power to help or to hinder them. But a man can change his climate. Between the equator and poles every kind of climate is to be found. One need travel but a few hundred miles up or down the globe to change one's climate radically. In a day or two of travel one can pass from intense heat to intense cold, or from severe drought to extreme wetness.



WHAT MAKES CLIMATE?

Since the beginning of time men have puzzled about what makes different climates in different places. It was found out very early that climates run in belts across the earth. We can travel a long way from west to east or east to west without changing our climate very noticeably; but go north or south a short distance, and we shall come into new weather conditions. So men made zones, or belts of climates, which were not very unlike our torrid, temperate, and polar zones. But they could not explain them fully till they knew some of the things which we know, and especially till they knew what made weather. We have seen that changes in weather are changes in the air. So we can understand that the climate of a place is really the condition of its air as to its heat or cold, moisture or dryness, healthfulness or unhealthfulness. When we can explain why the air should be as it is, we can explain climate.

THE SUN'S RAYS AND CLIMATE

The Egyptian astronomer, Ptolemy, got hold of one right idea about climate; only he did not explain it right. He thought it depended on the amount of sunlight a place received. So he made out a scheme of thirty climates running in belts across the earth from the equator to the pole, and divided them by the length of their longest midsummer day. The hottest climate had of course the longest day; the coldest, the shortest.

This was true as far as it went. Climate does depend on amount of sunlight; but amount of sunlight depends not only on the length of time during which we have the sun's rays, but also on the amount of air through which they have to travel before they reach us. This changes with different times of day and different times of year.

WHY IT IS HOTTEST AT NOONDAY

Our air blanket is of the same depth all round the globe. If the sun stood above every

point on the earth's surface all the time it would send its rays straight down by the shortest way, and would only travel the thickness of this blanket. If you want to throw a ball into a hole in the ground, and are standing right over that hole, you throw it straight down and it goes the shortest possible way. But if you are standing a little distance away, it goes slanting from your hand to the hole. It travels through more air than it did when you stood right over the hole. This is just what happens with the sun's rays. When the sun is high in the heavens at noonday, the rays come straight down and travel through the least possible amount of air; but in the early morning, and again in the late afternoon, they come slanting. The sun's rays are just as hot when they strike the top of the air blanket in the morning as at noon. But they travel through more air, so the air gets more of their heat, and we less.

WHY IT IS HOTTEST AT THE EQUATOR

Our planet, Earth, has, you will remember, two motions, one spinning round on its own axis once in each day, and the other turning round the sun in a year. The daily motion brings the sun's rays to us in such a way that it is hotter at noon than in the morning or afternoon; the yearly motion makes it hotter at the equator than at the poles. In its yearlong journey the earth keeps the middle part of the globe tipped in a more direct line with the sun than the poles. So the sun, when it shines down on the equator, shines for a longer time straight down through the air blanket, and the equator gets more heat from its rays than those parts of the earth which are usually tipped so that they get more slanting rays.

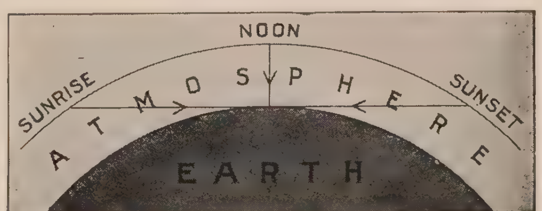
WHAT THE AIR DOES WITH THE HEAT IT TAKES UP

Ptolemy was right, however, when he thought the length of day had something to do with climate. If we depended for our warmth upon the direct heat from the sun's rays, we should be warm only when the sun shines. A cloudy day would always be very, very cold, and every night would be as cold as if there had never been any sunlight. But air helps us out again. It is probably just this way on the moon, where there is no air. An hour after sunset it is probably so cold that none of us could live there, just as an hour before sunset it would be too hot for us. But our air is really a blanket, and a good, warm one, at night. All day it has been taking up nearly half of the heat from the sun's rays as they passed through it. Now it has them all stored up, and as night falls, the earth, which has been storing up too, gives out its heat, and the air gives out even more. For the time being earth and air radiate heat; that is, give out heat rays as if they were making it, but really in the case of air it is all stored-up heat and in the case of earth most of that which is given out in the night is what has been taken up from the sun during the day. So it makes a real difference in the heat or cold of a climate whether it has long days of sunshine and short nights for earth and air to give out heat, or short days, when air cannot have time to take up much, and long nights, when it is forced to give out every bit it has.

It is interesting, however, to think that as moon and stars keep us from absolute darkness when the sun is gone, air keeps us from complete cold during the night.

OTHER THINGS THAT MAKE CLIMATE

The mistake of Ptolemy and all the other early weather students was that they thought climate depended wholly on sunlight. Climate, as we have seen, is nothing more nor less than the kind of air about us. It may be not only



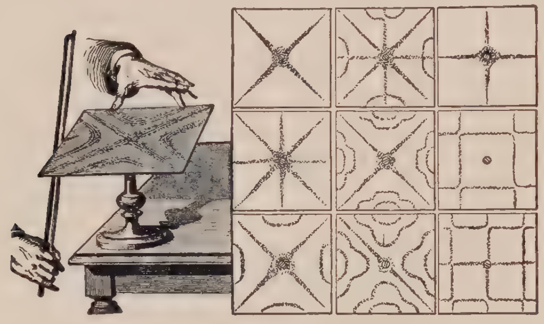
PATHS OF THE SUN'S RAYS

hot or cold, but wet or dry. This is where winds and the amount of water in a place and many other things come in to make climates different. But there would be no difference in climates at all, only terribly hot days and fearfully cold

nights, if it were not for the air which brings and keeps and gives out heat.

SOUND-MESSAGES

It is almost impossible to picture a world without sound, and yet that is what we should have if there were no air. The moon is probably an almost silent world. One of its volcanoes might crash down into one of its deep valleys, and still there would be no sound, for sound travels in waves made by particles of air. The first thing necessary to sound would have happened. There would have been motion; only when we talk of the kind of motion needed to make sound we call it "vibration." A pendulum vibrates, that is, it swings to and fro. There is a chance for sound whenever for any reason a solid body receives a shock that sets its particles to swinging or vibrating. Have you ever been on a steamer and felt its decks tremble and quiver as the screw turned round? That is the kind of thing that happens when sound is set up.



BOW, GLASS AND SAND EXPERIMENT

Sound-waves can be shown by putting sand on a glass plate, and drawing a violin bow across the edge. The sand will shake into patterns like these.

But there must be something also to take up these quivers, these vibrations, and carry them to the ear of the person who is to hear them. The air does that. It carries them along in waves like the waves of the sea until this quivering air strikes the drum of a person's ear and makes it shake back and forth with just exactly the same kind of vibration that was started by the solid which began the sound. Every sound has its own waves, which are of different length and force from those of every other sound. Then, when the waves have struck the ear-drum and made it quiver, it sends the news of that motion up by delicate nerves to the brain, and the person hears.

Three things are needed, you see, to make sound, — the vibrating body, the air to carry its vibrations in waves, and the ear, made to receive them, connected with the brain of an animal or human being. Without the air there could not be sound. Could there be sound without the person or animal to hear it? That is a favorite schoolboy's puzzle. If a tree fell down in the middle of a forest where there was no animal or human being with ears which could hear, would it have made a sound? Well, would it? That is for you to decide.

HOW SOUND-WAVES TRAVEL

When a wave is carried along in water or in air no single particle moves very far. The motion travels along through the air, each particle giving the one next to it a little push, and that one passing the push along to the one next it, and so on till the wave comes to some solid substance that stops it.

You can show this by putting a row of marbles in a groove in a board, or even in a rut in the ground. Put them so that they will touch each other. Then take another marble and drive it gently against the first one in the row. The blow given this marble by the one in your hand will be carried all down the line to the one at the other end; but if you do the experiment well and quickly, you will not be

SOUND-WAVES

able to see any of the marbles move except the one in your hand and the one at the farther end of the line. The force of the blow given by the marble in your hand has evidently been carried down the line, for the last marble will move away from the one next to it. But you have not seen the middle ones move. They did move, but only a very little. What they did, however, was to take up the motion, each from the one behind it. But when the first marble had struck the second, it gave up its motion and came to rest. The second gave it to the third, and in its turn came to rest. Each did it so quickly that unless you were looking very carefully you did not notice it. But when the motion came to the last marble, there was nothing to pass it on to; so it moved away from the end of the line. This is just the way the air particles take a shock that makes sound. Each makes its little motion and then comes to rest, but the sound-wave travels to the ear.

BOYS SHOWING WAVE MOTION

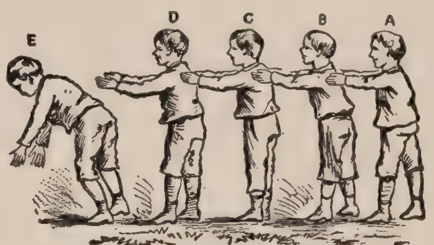
Professor Tyndall, the great scientist, pictures a sound-wave even more clearly by thinking of the air particles as if they were boys in a row, each with his hands on the shoulders of the boy in front of him. Here they are, five of them, A, B, C, D, and E. "I suddenly push A," says Professor Tyndall; "A pushes B and straightens up again himself; B pushes C; C pushes D; D pushes E; each boy, after passing along the push, becoming himself erect. E, having nobody in front, is thrown forward. Had he been standing on the edge of a precipice, he would have fallen over; had he stood in contact with a window, he would have broken the glass; had he been close to a drumhead, he would have shaken the drum. We could thus transmit (send along) a push through a row of a hundred boys, each particular boy, however, only swaying to and fro. Thus also we send sound through the air, and shake the drum of a distant ear."

It is worth while to put our minds on wave motion and learn to picture it to ourselves, for it is the way almost every message from the outer world comes to our human bodies. We become deaf and are shut out from the world of sound if our ear-drums cannot receive the message which the sound-waves bring to it. Blindness comes because the eye cannot receive light-messages. The universe is full of messages for us, all traveling along in waves. We get just as many of them as our bodies are fitted to receive and our minds to understand and interpret.

MESSAGES FROM OTHER WORLDS

THE SWIFTEST TRAVELER IN THE WORLD

HEAT and light come to us in waves, as sound does, but fortunately they do not depend on air to bring them. Sound can travel only through gases or liquids, or through some solid body, like a telephone wire. Heat and light can journey just as well through the invisible ether which fills all space. If they could not, we should be a solitary little world, for the sun and stars would be of no use to us. The sun's light and heat must be vibrated in swift-moving waves through ninety-one million miles of ether before they get to the top of our air blanket. Light travels farther than heat. We get light from stars which are too far away to give us heat. Light is the greatest traveler in the world. While sound is a little private earth affair, tied down within a hundred miles of our planet by the air blanket, light belongs to the universe. Some of its messages have come so far that we cannot even think the distances they have traveled or the length of time it took them to come.



TYNDALL'S BOY ILLUSTRATION

WHAT AIR DOES WITH LIGHT

Though light does not belong to air, yet air manages to do a good deal with it during the

THE SIX MONTHS' POLAR NIGHT WHEN THE SUN NEVER RISES

instant when the light-wave is rushing through it. In general, as we have said, air hinders the light, slowing down its speed and softening it by clouds and dust and dampness. But in this hindering of it, all sorts of beautiful and interesting effects are produced. Air shows us light in beautiful sunset colors; it helps us to see rainbows and "northern lights"; it splits it up and reflects it and changes it in a hundred ways.

READING LIGHT-MESSAGES

Messages are all very well if we can understand them; but if they are in a language we do not know or in a cipher of which we have not the key, they do not mean much. It is only within a couple of hundred years that men have had the key to light's cipher code. (If you do not know what a "cipher code" is, the Quiz Book will tell you.) It is a magic key, which unlocks more doors than any Arabian Nights story teller ever dreamed of. Hold it up in the bright sunshine or in the light of the distant stars, and it will show secret chambers which man never expected to unlock. What is this key? Only a prism, a little three-cornered piece of glass. Look through one and you will see a many-colored world suddenly rise up, with red and green houses, violet people, and yellow-red trees. This bit of glass is one of the greatest marvels known, for it is the key to light, and light has more secrets to tell than any other world force.

WHY THE PRISM MAKES COLORS

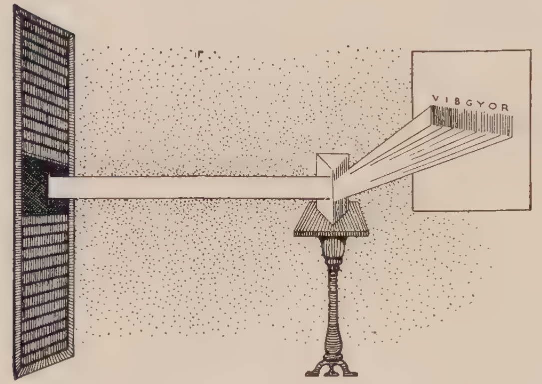
Did you ever play with a prism, turning it in the sunlight and watching the colored spots it will make on the wall? Twist it round and they will dart hither and thither, these little bands and bars of blue and yellow and red. Take your prism and go into a darkened room, letting a single ray of light come in through a slot in the shade. The sunlight, streaming in, will make a long, bright sunbeam in which hundreds of tiny dust particles are floating. If anyone asked you the color of the sunbeam, you would say white, or yellowish white, would you not? When the ray of light reaches the floor, it will make a spot or bar of white light.

Now take your prism and hold it in the sunbeam's path. You will have a band of rainbow colors on the floor in place of the bar of white light. Put a piece of white paper on the place where the sunlight falls, and you will get them more plainly. At first you may get only two or three colors. Turn the glass and twist it till you get them all, a perfect little set of rainbow shades—violet, indigo, blue, green, yellow, orange, and red. Do you realize what you have done? The ray of sunlight was white when it came into the room. But it is casting a rainbow of color on the floor. Think back to what we said about how light came to us by waves. You have split the white ray, which was a set of waves all coming together, into the waves of which it was made up, and these waves are giving each its color to the piece of paper on the floor.

THE MAKE-UP OF A RAY OF LIGHT

Sir Isaac Newton did this experiment with a prism two hundred and fifty years ago. He did not know, as we do, that light comes to us in waves, and so he could not give the right explanation of the colors made by the prism; but he did upset the idea which people had had up to that time that all light was naturally white. They had passed light through a piece of red glass and had said that it was dyed red by the glass. They had seen white light fall upon a green object, and had said that the object turned it green. But here was a beam of ordinary sunlight passing through a glass prism and coming out all colors of the rainbow. It was not to be supposed that the light had been colored by the glass, for the glass was colorless. The piece of paper on the floor on which it fell could not have turned it all these varied colors. Besides, they could see the colors, without any piece of paper or object for it to fall on, by looking right into the prism. Try this yourself. Instead of letting the beam of sunlight pass from the prism to the floor, kneel down and get right in its way, placing yourself so that one of your eyes is directly in line with the prism and the ray of light which is coming through it. Shut the other eye and look up into the prism. You can see all the rainbow colors coming out of the prism.

There could be no doubt that the prism somehow sorted out the various colors which made up white sunlight. But how did the prism do it? These questions waited for their right answer till the wave theory of light was proposed by Professor Thomas Young of London in 1804.



HOW A SPECTRUM IS FORMED

Then they could be answered in a simple but very wonderful way.

MORE ABOUT WAVES

As no one has seen or ever will see ether-waves, because no one will ever be able to see the ether which fills all space but is absolutely invisible, it is plain that we must draw on our imagination to picture light-waves. The nearest we can come to ether-waves in anything we can actually see is in a still pond upon whose smooth surface we can make ripples.

We drop a piece of wood into the center of the pond, and we see little waves spread outwards from the center in circles, one circle following another at regular intervals. If the pond is a small one, the first wave does not take very long to reach the shore, while the others follow in a regular march; but the piece of wood still remains at the center of the pond. If we had placed corks at different points on the surface, the waves would not have carried a single cork any nearer to the shore. The corks would have merely "bobbed up and down."

Sound-waves are not of this sort. They are of a to-and-fro motion, like the movement of the boys in Professor Tyndall's line, — forward, then back, and then to rest in the place where they started. This is the wave motion we see in the swaying of people back and forth in a crowd. Waves in air are of this back-and-forth kind. They are in the same direction as that in which the wave motion is traveling.

Now come back to our pond and think about the up-and-down wave, which is the only kind we have in ether. Looking at the ripples on the pond, we see that the wave motion is traveling from the center of the pond to the edge, while the vibrations of the corks, and therefore of the particles of water also, are up and down or at right angles to the direction of the wave motion. You see, we have come upon two kinds of waves, — one where the particles move backward and forward in the direction in which the wave motion is traveling, the other where they move up and down while the wave motion travels along just the same. All ether-waves, and therefore all light and heat waves, are of the up-and-down kind.

Does the pond illustration make you want to ask a question? If the water waves really go up and down, why are pieces of cork and wood and seaweed constantly washed ashore by the waves? Why don't they stay out at sea bobbing up and down? They would, if the water were let alone. They do in our small, still pond. But usually water's neighbor, air, comes into the matter and drives the water with her winds and currents, until its waves go forward as well as up and down. The moon comes in, too, with her pull and makes tides; and the earth, with her pull of gravitation towards her center. So we had better go back to our ether, where the sun and stars are sending out their waves without any interference. Modern science has invented delicate instruments to measure these waves.

WAVE LENGTHS

All ether-waves are of the same up-and-down kind, and they all travel with the same speed. The sun, for instance, starts vibrations, and there is nothing in ether to block them, or even slow them down, until they come to our thin little air blanket. But they do differ in the rate at which they follow one another.

Suppose instead of dropping a cork into the center of our still pond we had a float or

THE SUN SPECTRUM AS SEEN IN NATURE

See page 95.

plunger of some kind with a handle attached to it, so that we could move it up and down in the water. If we moved it up and down slowly, the waves would follow each other with considerable distance between; but if the motion of the plunger was rapid, the waves or ripples would follow close upon one another's heels. Far more waves would arrive at the shore in one minute when the plunger was moving rapidly.

If we wanted to compare the different sets of processions of waves, we could measure the distance from the top or crest of one wave to the crest of the following wave; or we could take the distance from the trough of one wave to the trough of the next. They would be the same, as would the distance between any two corresponding points on neighboring waves. This is what we call "wave length." It has nothing to do with the length along the front or ridge of the wave. By wave length we mean the distance between two successive waves. It might perhaps better be called the width or breadth of the wave; but length is what science has named it.

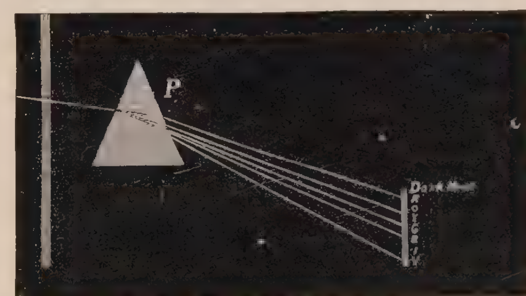
LONG AND SHORT WAVES

When we moved the plunger fast we got many waves following quickly on each other, that is, waves of short length. The only difference in ether-waves is in the rate at which they are made. They all travel at a speed of 186,000 miles a second after they have once been started. Later we shall see how this was found out, but the speed of ether-waves is one of the facts of which we are sure.

Think of the way we give handicaps in a race. We give them because the speed of the runners is not equal. But suppose the speed was equal and we let the second runner start ten seconds later than the first, and the third after the second. Now think of the sun as the starter, sending off waves. Nobody knows how many waves it does send off in a second. But take a small number compared with what it actually does send. If it set off one thousand waves during one second, the first wave would have traveled 186,000 miles when the last wave is ready to start. In other words, there would be a thousand waves equally spread over a distance of 186,000 miles. What would be the length of each wave? We do not even need a piece of paper to calculate it. Each wave will occupy a space of 186 miles. The wave length of each of the thousand waves would be 186 miles.

HEAT, LIGHT, AND ELECTRICITY

Some of the ether-waves used in wireless telegraphy are measured in miles; others are known to be as tiny as $\frac{1}{250000}$ of an inch. But everything which reaches us by ether-waves is given its own properties of heat or light or color or electricity because of its wave length. Long waves are set up — that is to say, far-apart waves — in ether, and we have electricity, by which we send our wireless messages. It sets up shorter waves, and we have heat; and shorter waves still, and we have light.



LIGHT-BREAKING BY PRISM

All of them are ether-waves, but some affect our eyes, some make our bodies feel warm; some, like the waves which carry wireless messages, make no impression on our bodies, but do on delicate instruments which man has been able within twenty-five years to construct.

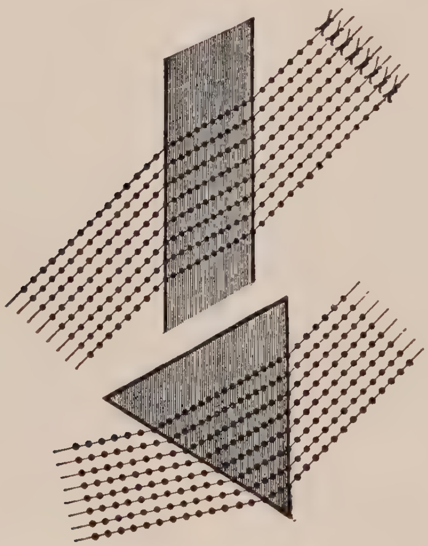
WHAT IS LIGHT?

Now we can come back to our prism and understand why it can sort out the colors from a ray of white light. Light we have found to be simply a stream of ether-waves of various lengths. When they fall on our eyes they make different sensations take place. If they all enter the eye at once, all "in a bundle," so to speak, they make a certain sensation which we call "white." It is as if a bullet flying

through the air struck a soldier and caused a sensation of pain in him. The bullet and the pain are totally different things. Light is not really white or colored. The ether-waves, flying through the air, strike the eye and make a sensation. When they strike all together, the sensation is white; when they are separated, we see colors, and different colors according to the lengths of the different waves.

BENDING LIGHT

First of all we must notice what happens when ether-waves fall upon any piece of ordinary glass like a window pane. If a beam of sunlight came straight at a glass pane, or, in other words, if it struck the glass at right angles to its surface, the waves would go straight through and keep on in a straight line. This happens when a ray of sunlight strikes a skylight in the roof and travels to the floor below the skylight. But picture the beam of light striking the glass at an angle and see what happens, remembering always that glass hinders the light-waves, because it is harder to go through than air, even as air is harder to go through than invisible ether.



BENDING A LIGHT BEAM

In the upper section a ray of light is going through a pane of glass; in the lower through a prism.

A SOLDIER ILLUSTRATION

The best way to picture a light-wave striking glass is to imagine a line of soldiers as representing the wave front. Think of them as marching well in line and approaching a stretch of rough country (the piece of glass). Remember that they are not going straight at it, but are coming in a slanting direction, so that the soldier on the extreme right will enter the rough country first. He will not be stopped; the pane of glass will let the wave through. But his walk will be hindered, and his pace across the rough country will be only two miles an hour as against three miles in open country. As each soldier enters the rough section his speed is cut down, but the soldiers on the extreme left of the line will have marched in the open country longer than the others. Therefore they will have kept up their full marching speed of three miles an hour longer than those who first entered the rough piece. These right-hand soldiers will have slowed down so much by this time that the direction of the line of march (that is, of our light-wave front) will be considerably altered.

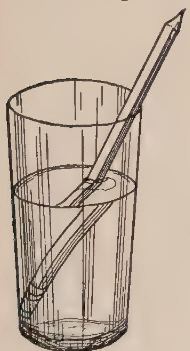
Once in the rough country they all march again in even line, but they are still marching in a slanting direction, though not at quite such a sharp angle as before. Those on the extreme right, who entered the rough country first, will be out again first, so that they will get ahead of those who were later in leaving the open country for the rough. What takes place now is exactly the opposite of what took place when they were entering the rough country. Those on the extreme right will make up their lost lead while those on the extreme left are being delayed by the rough country, and on the other side of the rough piece the line of march will swing round into the same general direction that it had way back on the open smooth ground.

While we have been going through this long story, millions of ether-waves, starting from the sun, have been striking your window pane at an angle, pushing their way through the glass, coming out again at the same angle at which they entered, and traveling across your room in slanting rays of sunlight. You did not see them bent in the glass, because the glass was so thin and they went through so fast; but it

happened every time, as you will be able to prove for yourselves some day in a physics laboratory, where you can see lenses bend light. You can try an experiment now.

HOW WATER BENDS LIGHT

This bending of light is called "refraction," from the Latin words, "to break back." Take a stick and put it in water, and you will see where this light-bending got its name. Light always comes to us in straight lines. It cannot turn corners or go in curves. That is why it casts shadows. If you come between the light and the wall, the light is stopped in its journey by your form, and the outline of your form stands out dark upon the wall. But when it enters a new substance, like water or glass, it is bent (refracted) in another line. The second line is straight, too; but it is not the same line as the first one. Have you found out what the light on the water has been doing to your stick? Try it with a pencil in a shallow basin full of water. Your stick does not look straight any longer. It looks as if it had a joint in it where it struck the liquid. But it is still straight, is it not? Yes, but it looks bent because the water bends the light rays and sends them to your eye from another direction.



PENCIL BENT BY LIGHT

REFLECTING LIGHT

When light strikes something which it can travel through, we call that body transparent. It may refract the light, but it will let it go through and come out on the other side. Most things, however, do not let light pass through them. The ether-waves strike the surface and are *reflected*, that is, turned back. A mirror reflects your image back to your eyes. The sunlight falls on the ground and is reflected up to our eyes, else we should not see the ground. The moon floating in the sky reflects the sunlight to us, else we should never know there was a moon. Only a few things shine by their own light. They are what we call "light-giving bodies," such as the sun, the stars, electric lights, lamps, candles. They give us light directly. Everything else reflects sunlight. When it is dark, when the sunlight is shut off and there is no light in its place, not only do we have no light, we do not even see the things about us. Unless we run into them, or hear them, or smell them, we should never know they were there.

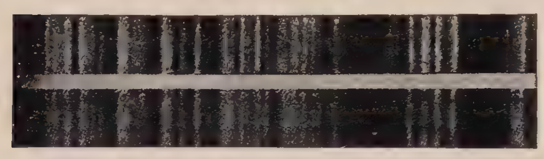
WHAT MAKES COLOR?

Different wave lengths make different colors. When you bent the ray of sunlight by the prism, you separated these waves so that they showed their colors. Going through a window pane, the marching army of your wave front had a chance to get together again in the same direction and come upon your sight all at once as white light. But your prism was three-cornered and three-sided as well as transparent. It was as though your line of march entered not a straight patch of country with its two boundary lines parallel to each other, but a triangular one, where some soldiers would cross only a little corner and others go through the middle. Besides, when we consider light-waves instead of marching soldiers, we must keep in mind that some are bent more than others by glass; that is, some find it harder to march through. The shorter the wave, the more it will be bent. Your prism takes the rays of light as they strike its surface and bends them in carrying them through itself, sending them off at different angles, so that they do not come out all at once. They are also split up by being turned, and they can't get back together because they must travel in straight lines. So we have on the floor the mark that each ray would make if it could come alone.

THE SOLAR SPECTRUM

The band of colors given out by the prism is the band of sunlight colors which our eyes can see. It is called the "solar spectrum," or sun image. The colors are always in the same order. Violet rays are shortest; so they come at one end; red rays are longest, and between come indigo, blue, green, yellow, and orange.

But when we talk about length or shortness, let us stop to find out what sort of lengths we are really talking about. The wave length of red may be longest, but it takes thirty-four thousand red waves to cover an inch. Violet rays are so short that it takes sixty-four thousand waves to make an inch. These are the tiny waves beating incessantly on earth which make what we call "color."



SPECTRUM OF THE SUN AND OF THE STAR CAPELLA

Each star has a spectrum of its own. Capella's is very like that of the sun.

Another way to get some idea of the rate at which the sun sends them out is to calculate how many of them pass any point in a second. It has been worked out that of waves producing the sensation of red, about four hundred billion would get by in a second; of orange, four hundred and forty; yellow, five hundred; green, five hundred and seventy; blue, six hundred; indigo, seven hundred; and violet, seven hundred and fifty billion. It is no wonder we see color with all these waves pouring in on us, is it?

THE KEYBOARD OF ETHER-WAVES

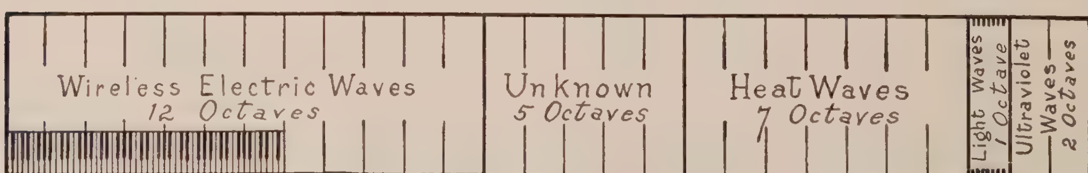
We get reflections from only a few of the ether-waves which make light and color. Most of the light-waves are too slow or too swift to make any impression on our eyes. This seven-color spectrum with its various shades, which the prism has shown you, reflects only about one thirty-fifth of the light-waves which come to earth. It is as if the spectrum of visible light were an octave of a piano. The ordinary piano has seven octaves. To represent the light and heat waves would take at least ten octaves, while to show all the ether-waves would require from thirty to forty octaves.

WHY DO THINGS HAVE DIFFERENT COLORS?

The prism was transparent. It took up all the waves of light which struck it, carried them through, and sent them out again, to give all seven colors and their shades between them in a perfect spectrum on the floor. But most objects are not so obliging. They take up some of the ether-waves and keep them; others they reflect back to our eyes, and we say the object has the color of those waves. It is easy to believe that everything is without color in the dark when no light is falling on it. But it is harder to believe that the color of a body is due to the ether-waves which it takes up or does not take up. But this is true. A piece of red cloth is red because when white light falls on it all the colors of the spectrum but red are absorbed or turned into heat, the red waves only being reflected to our eye in ether-waves. The color of an object comes from something in itself which makes it take up certain light-waves and reflect certain others.

WHY DO THINGS CHANGE COLOR?

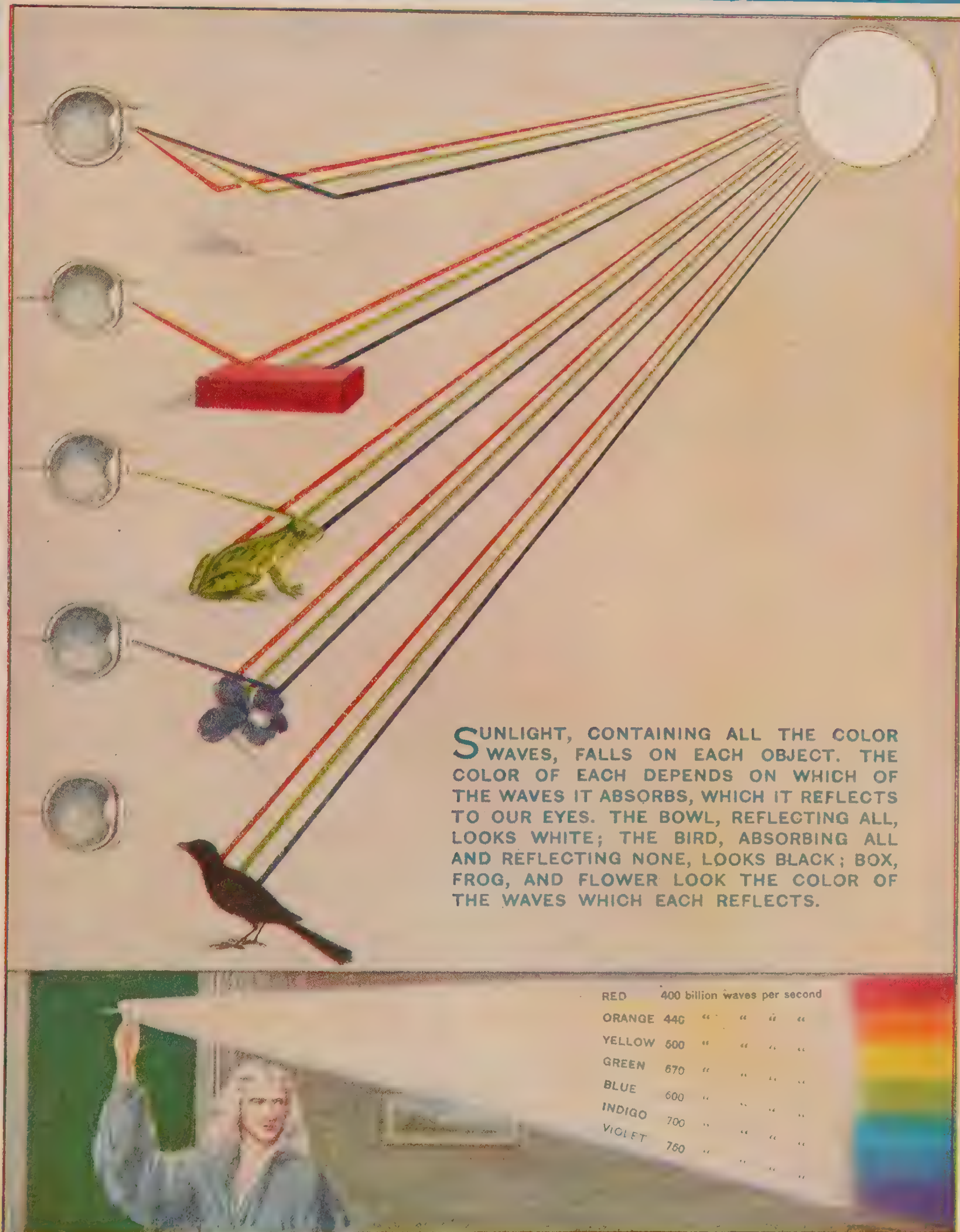
Did you ever buy a pink ribbon and find that it looked yellow at night under artificial light? Or have you ever seen your mother take a piece



THE KEYBOARD OF ETHER-WAVES

Just as sound-waves are divided into octaves, seven of which cover the range of an ordinary piano, so ether-waves might be thought of as making up, from the longest to the shortest, twenty-seven or more octaves. On the left are the twelve employed in wireless telegraphy; next, five of which scientists know almost nothing, because they have not instruments delicate enough to record or study them; then seven heat waves, which we feel but do not see; one (our spectrum) of light and color waves; and, last, two called ultra-violet rays, invisible to the eye but used in photography and other chemical changes.

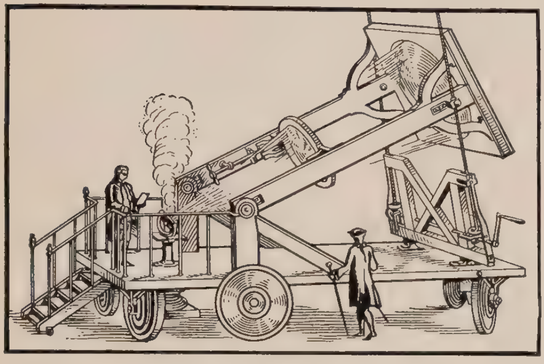
WHY WE SEE COLORS



THE MAKE-UP OF A RAY OF LIGHT

Hold a prism in the sunlight, as Sir Isaac Newton did, and see the band of colored light it throws. This sun spectrum is represented above by the red, green, and violet lines. Color waves have different rates of speed. When waves of light hit your eyes at the rate of about four hundred billion waves a second, some of the three million tiny "rods and cones" at the back of your eye which attend to your color vision respond, and you see red. If you are color-blind, some of the rods and cones are failing to act. The bird reflects light, else you would not see it, but not color.

of goods to the door of a shop to find out what color it was? If so, you will be more ready to believe that the same thing will not have always the same color. In sunlight it will look what we call its "real color," its daylight



BERNIÈRE'S BURNING-GLASS, 1757, WHICH GAVE OUT HEAT ENOUGH TO MELT METAL

color. But artificial light — gas, electric, or lamp light — will not have so many wave lengths as daylight, and the ribbon or cloth or book will take up different lengths and look a different shade.

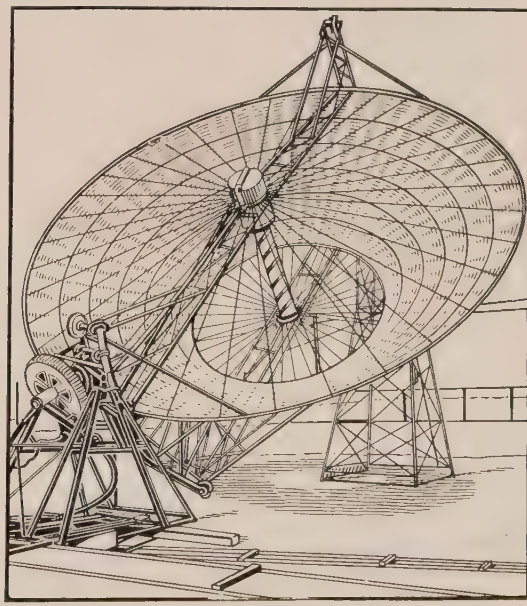
ABSORBING HEAT

Light-waves are not the only ones which are absorbed when they hit against solid bodies. Heat absorption is one of the most common experiences of our lives. A kettle absorbs heat and keeps it for a long time after it is off the stove. A "burning-glass" will catch the sun's rays, bending and absorbing them and then giving them out in great heat. Forest fires are started by sunlight on glass bottles lying among dry leaves, which are lighted from the heat of this "burning-glass." One should never drop glass in an exposed place in the woods, lest it start a fire in this way. There are even sun motors, run by the sunlight, turned into heat, and then into energy.

It is an interesting fact that heat and light rays seem to meet the same response in certain cases. In hot countries people wear white, and both "look cool" and are cool. White throws back all the rays of light and heat that it can. Black takes them all up. Take two pieces of cotton cloth of exactly the same quality, one white and the other black, and put them on a snowbank where the sun is shining. The snow under the black cloth will melt long before that under the white; the black cloth has absorbed the heat-waves and passed them on to the snow, while the white cloth has reflected them (turned them back) and thus protected the snow. Kinds of cloth make even more difference with heat than colors, but even colors seem to have a real effect.

WHY THE SKY IS BLUE

We go "all round Robin Hood's barn," as the old saying has it, studying out facts and laws which seem very far away from our everyday life, and then all of a sudden they have brought us back to some simple happening which is so familiar that we have never thought to ask the reason for it. We study wave lengths of light, and find out why a piece of cloth is red. We learn about our air blanket with

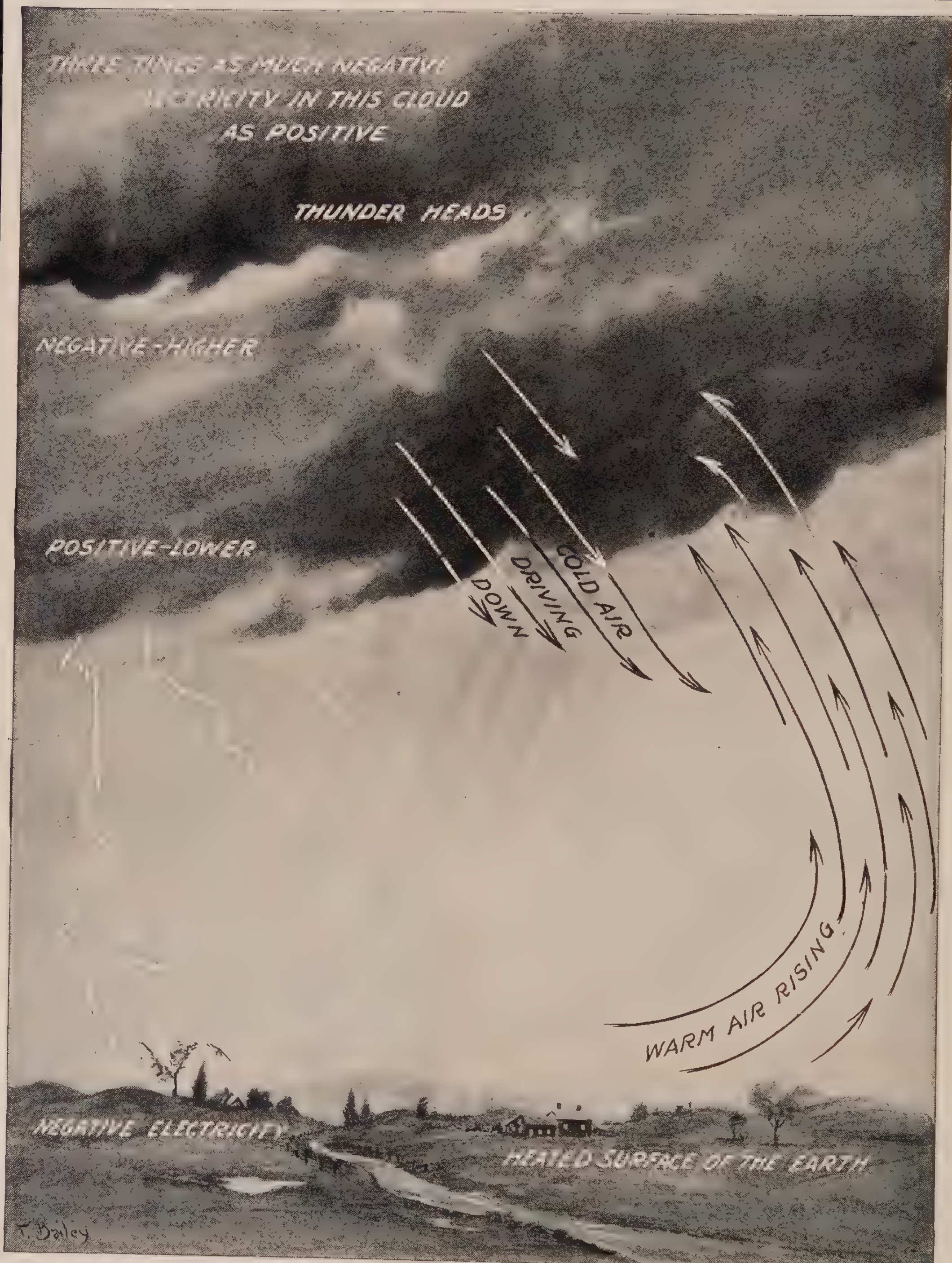


SUN MOTOR, ON A CALIFORNIA OSTRICH FARM

its water-vapor floating in it, and all at once we can tell why we look up into blue sky.

Water is one of light's best reflectors, and it reflects blue. We know how blue the ocean is, and how blue lakes and ponds can be. In the

WHAT HAPPENS IN A THUNDERSTORM



HOW THUNDER AND LIGHTNING COME

The surface of the earth and the air immediately above it become warmer than the upper air. Warm air rises, clouds gather, cold air begins to drive down. Rain falls. Clouds and air currents acting on each other set electricity free. When the positive and negative electricity meet, there is a flash of lightning. The sound of thunder comes when air rushes in to fill the vacuum left after the flash.

same fashion the tiny water particles in the air blanket around the earth take up other sun-colors but reflect the blue. When we look up at the overarching blue sky, we are looking at the arching air blanket which is over us catching light as it travels through it at the rate of one hundred and eighty-six thousand miles a second.

Professor Tyndall was the first to suggest why the sky was blue. He found that the thinnest vapors, when they were first given off from liquids, were always blue. If the air was transparent, with no water-vapor in it, all the colors would be caught in it and our sky would be black.

CLOUD COLORS

Professor Tyndall also found that as his vapors grew more dense and thick they became white and looked like clouds, just as steam pouring from a kettle will look white when it is thick. When they were still heavier they turned black, like our rain clouds. From what you have read, could you tell why clouds have different colors? The very fleecy clouds are white because they are not very thick. They are nearer vapor than liquid. As the drops of water form in them, they get darker; they take up more light-waves and reflect less, till finally they take up all the light they can, and look black.

Sunset colors come when the rays of the sun are slanting as they strike the earth, and the clouds act like a prism, separating the waves and letting the colors which are least turned from their course — yellows, oranges, and reds — alone pass through. Variety in colors of clouds depends not only on their thickness but on their height, and so we see in our western sky banks of color, one upon another.

THE RAINBOW

When do we see rainbows in the sky? When the sun comes out after a shower. The rainbow is nature's sun spectrum, or sun image. A flood of sunshine takes the place of the single beam of light which we let into our darkened room, and thousands of tiny raindrops are serving as prisms to make the wonderful arch which reaches across our whole sky. Many a boy has made his own rainbow on a sunshiny day by tossing a rock into a pond or stream so that the sun and he were on opposite sides of the spray. Then a small rainbow will appear in the spray with its flash of beautiful colors.

THE AURORA BOREALIS

More mysterious and less frequent than the rainbow or the sunset colors is the appearance in the northern sky of the beautiful arc of colored bands or streamers of light reaching far into the heavens, known as the "Aurora Borealis" or the "Northern Lights." These are seen to the best advantage in the arctic regions, but the fan-shaped band of brilliant searchlights is often visible also in the more inhabited regions of the earth.

Only with the recent understanding of the nature of electricity has it been possible to explain or interpret this beautiful and mysterious spectacle. In Volume XI, the nature of electricity as a stream of infinitesimally small particles pouring out from different sources is discussed. One of these great sources is the sun. From it there must be bursting forth, second by second, and moment by moment, enormous charges of electricity. The earth, meanwhile, is a mighty magnet, with its two magnetic poles located at the northern and southern portions of the globe. In some way the action of the stream of electrons as it strikes the boundaries of the atmosphere is changed so that they are deflected towards the poles of the earth and produce this brilliant color effect. As to the colors themselves, a brilliant Scandinavian professor, Lars Vegard, has recently advanced the theory that the green color, which has been the most perplexing phenomenon, may be reproduced in the laboratory by throwing electric rays on frozen nitrogen particles. So electrons from the sun bombarding an atmosphere of heavy frozen nitrogen dust are the probable cause of this beautiful display of colored lights.

THUNDER AND LIGHTNING

Benjamin Franklin with his kite was the first to draw electricity from a thunder-cloud and

so to prove that the lightning flash and the thunder-clap were both caused by electric currents in the atmosphere. Prometheus had tried to steal fire from heaven and had been chained to a rock for thirty thousand years as punishment by Jove, the king of heaven.

LIGHTNING, SHOWN BY AN INSTANTANEOUS PHOTOGRAPH

But Franklin escaped unharmed, and started us on our modern use of electricity.

There are many kinds of thunder-storms and lightning flashes. Here we can only say that they are traveling storms, in which the clouds and air currents act upon each other in such a way as to set the electricity free. The lightning is the flash of electricity; the rolling of thunder is caused by the rushing in of air to fill the vacuum made by the expansion of air due to the lightning flash.

LIGHT TRAVELS FASTER THAN SOUND

We often see the flash of lightning some seconds before we hear the sound of thunder. The two sets of waves were set up at the same instant, but they traveled at different rates of speed. The light went much faster and reached us almost at once; the sound came traveling along behind. We can tell by the length of time between our sight of the flash and our hearing of the sound how far away the storm is.

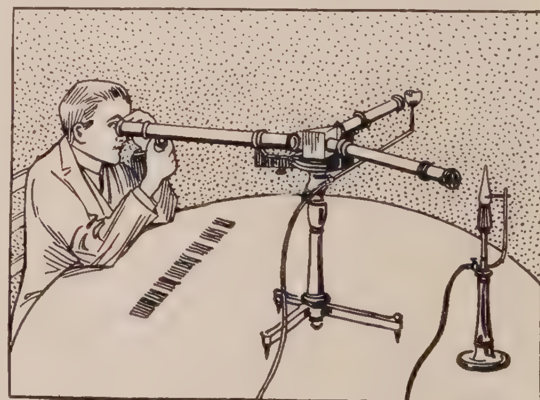
It was Jupiter's moons that taught scientists the exact rate at which light always traveled. Galileo found these moons with his telescope. Then all the astronomers studied them and discovered to their surprise and distress that they did not keep time. As the four little moons traveled round Jupiter in the orbits which the astronomers had worked out, they would disappear into the shadow of the planet a quarter of an hour sooner than was expected, or they would lag along a few minutes late.

An astronomer named Roemer worked on the puzzle for a long time, and at last, in 1675, he solved it. The moons kept time, but it took them a certain length of time to get their message of light to earth. Jupiter was not always the same distance from us. In the great orbit through which he traveled, he was at one time on the same side of the sun as the earth, and only 394,000,000 miles away; but six months later he was on the other side of the sun, and 580,000,000 miles away. This made a difference of 186,000,000 miles, and a delay in the arrival of light from the moons.

Roemer knew how far away Jupiter was, and made his reckoning. When Jupiter was farthest away, it took his light sixteen and one-half minutes more. By simple division he could find that the light traveled at a rate of 186,000 miles a second.

FORCES WHICH PLAY ABOUT EARTH

Heat, light, sound, electricity, and magnetism — these are some of the forces that play

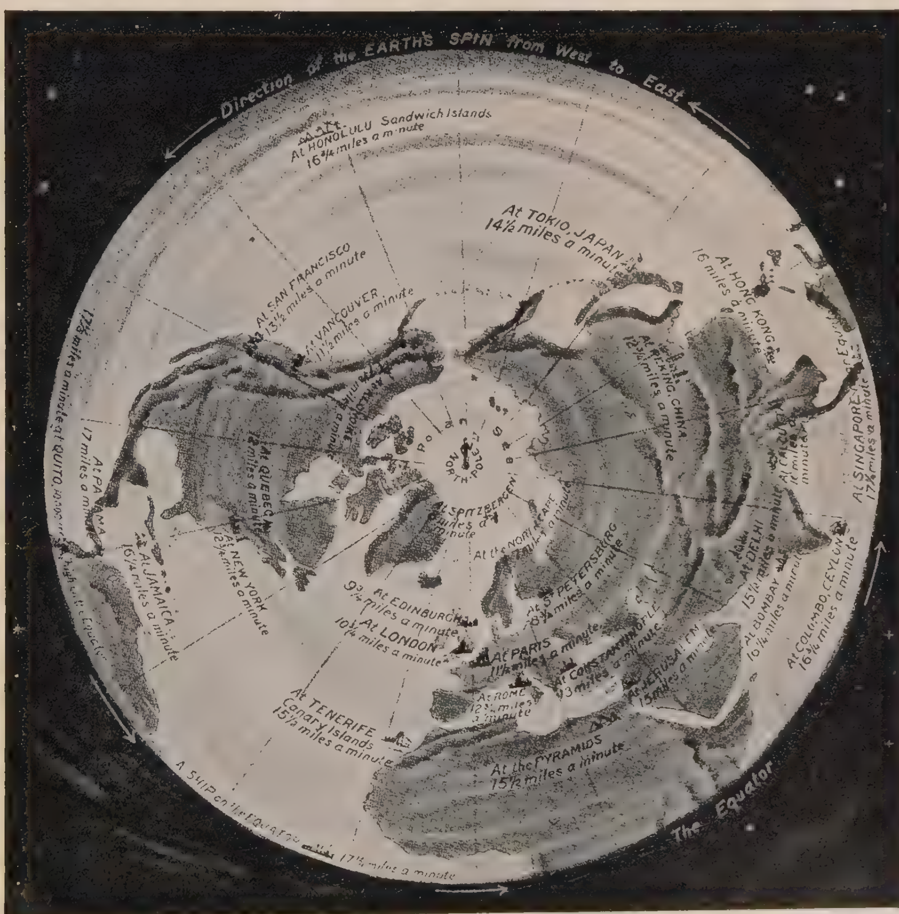


EXAMINING THE SPECTRUM OF A SUBSTANCE VOLATILIZED IN THE FLAME

about the earth on which we live. Of the last two we have said hardly anything. They act in the air and in the earth's crust. Their story will come in the story of inventions, for its interest is in the way man has used them. All these forces belong in the earth story be-

cause they act constantly upon the earth, making it warm and bright, and giving it the power to keep up life. If it were not for these forces there would be no human beings on earth. If they did not all work together in a beautifully adjusted balance, so that light cannot dazzle us, heat cannot get away from restraint and burn us up, and so on down the line, man would never be able to make earth his dwelling place. But they do all work together, making earth fit to live on.

Man has done much more than receive these forces and live in their presence. He has set them to work for him. We have hinted at only a few of the uses he has found for them. He has sent sound-waves over the telephone wire, and caught them in the graphophone; he has set electricity to work, giving him light and heat; he has turned heat into energy so that it drives his trains and his factory engines. Every day man finds some new way to make these willing forces his servants, and the story of how he has done this is the story of his inventions. *Invention* comes from the Latin verb, "to come upon" or "find out," and means nothing in the world but what has been found out. When you have read that story you will see that, wonderful as earth with all its forces is, man who can master it with his mind and make it do his bidding is more wonderful still.



THE SPINNING EARTH ON WHICH WE LIVE

Note that the earth's speed increases as you get farther from the pole.

THE CREATION OF THE WORLD (from a very old print)

HOW THE WORLD WAS MADE

SOME OF THE CURIOUS STORIES OF CREATION AS THEY ARE FOUND IN MYTHS AND FOLKLORE

WHO made the world, how was it made, and how did man come to live here? These questions have been asked by people of all races and ages. The stories told about the beginnings of things are as quaint and strange as they are old. Some of them begin with gods at play, tossing pieces of matter about in space; others with good and evil spirits warring in heaven. Indian tales start with a very wonderful being in the shape of a coyote. All of them make fascinating reading, and they are worth while, too, because they are real stories, not made-up ones. This does not mean that they are true, like the science stories we have been reading; but they were once thought to be true. That gives them a different sound, as you will find when you read them.

These myths, as they are called, are all wonder stories. In the childhood of the world people looked out on everything with eyes of wonder. No story was too strange or impossible to explain the marvelous world in which they found themselves; and so these myths grew up. They were not made by one person, nor all at one time. Every child, as he grew and used his eyes, asked questions, whether he was an Indian boy or a Chinese or an Egyptian, and as he came to manhood and saw more wonders he asked more questions. Fathers and mothers and story tellers and priests answered these questions, and the answers grew and were handed down from father to son and from story teller to story teller, until each tribe and nation came to have its own set of myths explaining the wonders of the world. Now, after hundreds and thousands of years, they are written down in books for us.

As you read them, you will notice two things. Though they are different stories, still they are very much alike. The Indians never knew that there were Eskimos away up in the north, and the Eskimos never suspected that there was a southland. But though they lived so far apart, they all belonged to the great human family. They all had the same kind of minds, which asked the same questions and, what is even more wonderful, answered them in about the same fashion.

The other thing that you will be amused to notice is that every nation and tribe thought it lived in the center of the world, and that the first man and woman were of its race. After all, don't you feel that way yourself? These child-peoples of olden times were very sure of it. The Indians were sure the first people to live on earth were Indians, who lived in America; and the Chinese were just as sure that the first people were Chinese with yellow skins

and slanting eyes, who lived on the other side of the world.

INDIAN MYTHS

ONE of the most curious and characteristic of all the stories is the first one given, the Creation Myth of the Crow Indians, native Americans, whose home is now in Montana. It is very old, no one can tell just how old,

THE SACRED SYMBOL OF THE TRIBE

and it has been taught by one generation of Crows to another through many hundreds of years. One day a white man, who made friends of the oldest living Crow chiefs, got them to tell him the tradition of the tribe, going back to the creation of the world and the first man. That first man, they said, was surely a Crow Indian. But here is the very singular story, as Mr. W. F. Petzoldt took it down; and this is the first time it has been printed in a book.

CREATION MYTH OF THE CROW INDIANS

In the ole time, 'way back, they know 'bout this world that there was no land at all, nothin' but water. There is nothin' on this water but Ee-sah-kwar′-te (or "Old Man Coyote," the Creator), nothin' but him, and he was travelin' roun' all time. Some wild ducks he say to them, "Brothers, come over here." He did not make them, they were just there. They come and he say, "Brothers, this ain't very well for us to live roun' on this water alone." He told the ducks that under this water there was land. Then he say, "One of you go down and try get some in your mouth."

One of him they went down in the water and after he went down and come back without it he didn't bring it. One other duck say, "Brother, let me go now." This duck went and doved down and come up without it again. A third one he say, "Now I go down." He go down, stay long time, and come up without it.

The fourth duck say, "Why did n't you send me down, these others, they ain't much count." He went down and bring up some sand in his mouth, and show to Ee-sah-kwar′-te and say, "Brother, here your sand."

HOW LAND WAS MADE

Ee-sah-kwar′-te pick it up and hold it in his hand. When he hold this sand it dry up, nothin' but dirt now. He told these ducks, he say, "When this was threw aroun' it will make a big land." He throw the dirt four times and the land keep gettin' bigger. After he threw this dirt there is nothin' but land now, no water any more. He make this land nothin' but plain, all level. Ee-sah-kwar′-te say to them ducks, "Brothers, they is nothin' on the ground now and I will make a mountain,[1] rivers, and all kinds trees, choke cherry and plum trees and Indian turnip, and grass, and springs, and stones."

CREATION OF MAN

Bime-by he say, "I make lakes, so you ducks can live." He told those ducks after he get through all this, why, he told them, he say, "I will travel roun' thinkin' 'bout things, 'bout what more I make." He went all roun', and after he travel long time he stop and talk to himself. He say, "I 'm all alone, 't ain't very well for me, I will make a man." So he go to the river, take some mud and make man. He made four mans of the mud and took them to where a big tree was hollow. It had a big hole, and he put them in and keep them there.[2] Then he go 'way many days, and come back

[1] This mountain is Cloud's Peak, near Sheridan, Wyoming, and was made right where Ee-sah-kwar′-te was standing at the time of the creation.

[2] One of the narrators stated here that Ee-sah-kwar′-te went to the tree and, striking it, called out, "Man, come forth."

to see if those mens be livin' right. He took one out and look at him, and there is no eyes in its face. There was nose and mouth, but no eyes. He say, "Well, I fix that all right," and he pinch out two little pieces and there was eyes. He ask this man, "Can you see roun'?" And this man, he answered back, "Yes, I see everything now." Then he call the man Ab-sor-a-ka (the word for Crow Indian). Ee-sah-kwar′-te told him, "You go back and make all rest of them like I show you do." He go back and fix these three mens just like himself, so they have eyes, too.

WOMAN AND THE FIRST TRANSGRESSION

Ee-sah-kwar′-te took some more mud and made four womens and give to the mens. He gave one to each man, and said to him, "That is your wife." These womens dress like the mens. Then he tell them, "Now you go out and travel roun' on the world, and you peoples will grow up. There will be lots of peoples, but there will always be more land than peoples."

Then he go off, too. These mud peoples be by themselves, and after long time he come back to see how they get along. He found that 't ain't right. These womens act bad, run away from their husbands. He bring them back and change them. He makes short leggins and a dress down to the ankles, and then they can't run 'way any more.

THE ANIMAL CREATION

Ee-sah-kwar′-te then take more mud and make all kinds of animals. He make deer, elk, antelope, and bugs, and snakes, and worms, and buffalo, and all rest of animals and birds and fishes. He thought he made everything, but he forgot one. A prairie chicken come down, and say to him, "I want to be an animal in this world." Ee-sah-kwar′-te tell him, "I 'm finishin', I 'm done. I don't think I can do anything with you at all, but anyhow I try to make you if I can." So he kill a buffalo, and took muscles on front leg to make body. He kill rattlesnake — so it buzz. He settin' there thinkin' 'bout this prairie chicken. He got body and tail but ain't got no nose. So he take gray wolf's claws and he make a nose on the chicken. He take more claws and make feet. He make wing of bear's claws. He put feathers all over this chicken. He tell the people, "All animals be in this chicken, him good for everybody to eat." (The prairie chicken, or grouse, is now the only game left to the Crow tribes, which once hunted over all the West.)

INTRODUCTION OF WEAPONS AND FIRE

Then he go 'way, and after travelin' roun' come back to see how his peoples get along. They say to him, "We see lots of buffalo and lots of game that we like to eat, but we can't eat." Ee-sah-kwar′-te told him that he forgot somethin'. He say, "You get one of them cherrywood sticks." After they brought up this wood, why, he make a bow, and after he got through making his bow he make arrow. He put flint on arrow. Then he gave to the mens and say, "My brothers, you go out and kill buffalo and deer and elk, and you make shirt from deer skin and robe from buffalo." Then he tell them how to make fire and cook meat. He took grease wood and sand and dry buffalo chips and rub sticks together in his hands and the smoke come out. Then he get dry grass and put down this smoke on top of grass, and that way he make fire.

CROW CHIEF ON THE WARPATH IN THE DAYS OF CUSTER'S RAID

WHY NOSES DIFFER

After he fix fire he go 'way. He gone long time but come back to see these peoples again. He is glad so many peoples now on world. They got teepee, meat and buffalo, all they

COYOTE AND EAGLE

want to eat. 'Fore he go in teepee he know his face ain't very good. He had a very funny face, not a good face like he made for these mud peoples. So he went back to the creek and took mud and make mud nose on himself. He make nice nose on himself and went in one of teepees and these peoples they don't know who he was. Ee-sah-kwar′-te, they didn't know him. He went in and sat down, and one womans she had a baby to hold. So he hold the baby and make it dance on his knee. The baby move its arm up and knocks the mud nose off Ee-sah-kwar′-te. So he took this baby and set it on the floor. He put hand to his nose and said to womans, "Excuse me, I got the nose bleed," and go out. Ee-sah-kwar′-te make such bad nose on himself, so all people on earth have different noses, some good faces and some bad faces.

Remember that this tribe of Indians, now living on its reservation lands in Montana, had no written language, and that its history was known only as it was told from father to son. No Crow ever doubted for a moment that the first man made on the earth was a Crow Indian, and the Crow has always been the sacred bird to this people.

A CALIFORNIA INDIAN MYTH

The Crow Indians thought the first land created by Coyote was Cloud's Peak, near Sheridan, in Wyoming. The Karoks, or Up-River Indians of California, thought California was the first bit of land. Their story takes up that of the Crows and tells a great deal more fully how land happened to have mountains and valleys.

Coyote and Eagle created Earth, says the old Karok story teller. In the beginning it was all dark and quiet. There was nothing but water anywhere. Coyote and Eagle lived up in the sky, where there was another world quite like this one.

Coyote got very tired of this sky-world. So one day he cut a hole in the sky and looked down. Underneath there was all water. So Coyote went down. When he got to the water he made a little island. He scratched it up with his paws out of nothingness. Then he sat down on it.

Eagle was away when Coyote made the hole in the sky. He came back and called Coyote. But there was no Coyote there. Then he hunted for him, but he could not find him. At last he found the hole in the sky. He looked down through it and there sat Coyote on the little island which he had made. Eagle said, "I will go down and find out what Coyote is doing."

So Eagle went down and sat with Coyote on the little island, but it was very small. There was not room on it for them both.

"This is not enough land," said Eagle to Coyote.

"Very well," said Coyote, "I will make some hills."

So Coyote made hills.

Eagle went and perched on them.

"These are very good," said Eagle, "but they are not high enough. I must have mountains to perch on."

"Then make them yourself," said Coyote.

"I will," said Eagle.

So Eagle went to work. He scratched and he scratched till he made great, high ridges that stood above the waters.

"There," said Eagle, "now I can perch."

So he flew to the top of the highest ridge he had made. (This was a mountain near the Klamath River in northern California.) Here Eagle sat.

While Eagle had worked over his task, some of his feathers had dropped down and taken root in the earth. Now they grew up and became trees and covered the sides of the mountain. Eagle's pinfeathers became bushes and plants. Eagle's mountain was done. It was the first mountain in the world. Afterwards Coyote and Eagle made other hills and mountains.

THE BIRTHDAY OF JAPAN

THE story which the Japanese tell of the beginning of the world is different and very beautiful. You will be interested in it because it shows why the Japanese give such honor and worship to their emperor, who is to them not only an earthly ruler but a descendant of the gods.

It was in the far, far off long ago, in the days when the stars were young, that there was no beautiful earth and no blue sky flecked with fleecy clouds, but only a great collection of matter out of which earth and sky were to be formed. Gradually the "sky-matter" drew away from the "earth-matter" and pretty clouds appeared wherever the earth and sky kissed each other. On one of these wandering islands of the sky there grew a reed, tall, with slender leaves, and handsome. But the reed was all alone in the world, and because it was lonely it began to wish and wish that it were a god. Indeed, it wished so hard that at last it *did* become a god. Then the reed-god made other gods one after another, but with none of these was the reed-god wholly satisfied; so he set about to bring to life two really great gods. These were called Izanagi and Izanami.

Of course the only world of the ancient Japanese was their own beautiful island empire. For them the world was all islands. They could not imagine a world that was not made up of countless islands, big and little. According to the Japanese story of creation, Izanagi and Izanami made the whole Japanese empire, and hence were looked upon as the great gods of all the hundreds and hundreds of gods in whom the ancient Japanese believed.

"THE WAY OF THE GODS"

One starlit night Izanagi and Izanami were out walking on the Bridge of Heaven. They felt sad that they had no land, no country they could call their own. Izanami pleaded with Izanagi to create some country where they could always live with one another. Now Izanagi possessed a magical staff, ornamented with bands of colored gold and silver and studded with all manner of precious stones, diamonds, emeralds, rubies, and sapphires, so that it glinted even in the darkness with a thousand shades and hues. And when he was touched with the pleadings of Izanami, he leaned over the balustrade of the Bridge of Heaven and thrust his staff deep down into the bed of the ocean, which he stirred violently until clods of mud from the ocean bottom came floating to the surface of the seas. These became the eight great islands of the empire and soon were covered with rich forests and grassy plains, watered by clear brooks and mountain streams, with the great snow-capped mountain of Fujiyama looking down upon a thousand valleys and a thousand hills, while the spirit of quiet and peace rested over all. But the little islands of the kingdom were not yet

IZANAGI AND IZANAMI ON THE FLOATING BRIDGE OF HEAVEN

formed. These Izanagi made by blowing his breath on the sea-foam, which, lo! was changed into a multitude of islets green to their water's edge and scattered all over the kingdom, along the coasts of the larger islands, in the bays and harbors, and in the Inland Sea, like ten thou-

sand floating emeralds, till the whole empire was a giant fairyland. This, indeed, was a land for the gods, and the Japanese called their islands the Shinto land, Shinto meaning the "Way of the Gods."

"THE EIGHT ISLAND COUNTRY"

When Izanagi saw the richness and beauty of the land, he said to Izanami, "We have now produced the great Eight Island Country, with mountains, rivers, herbs, and trees. Why should we not produce someone who shall be lord of the universe?" So together they made the sun. All that they made they called their children, and when they had finished making the sun, they both together exclaimed in tones of admiration, "We have had many children, but none of them has been equal to this wonderful child. She ought not to be kept long in this land, but we ought to send her at once to heaven, there to take charge of all the important affairs of the sky." So they made her climb up and up and up the tall sky ladder till she reached heaven, where she has ever since been chief ruler. Next, Izanami and Izanagi formed the moon, and because he gave out a beautiful and soft mellow light, they sent him to heaven by way of the sky ladder to rule over the night. Many, many other gods and many parts of the universe did Izanagi and Izanami make, but when at last they attempted to form the vicious Fire God, Izanami was terribly burned and quickly died from the wounds so received. Izanagi was greatly grieved over his deep loss, and in the period of his sorrow every act he performed resulted in the creation of another deity, or god, till the earth contained a multitude of them. He washed his left eye and a deity was born, he washed his right eye and a deity was born, he washed his nose and a deity was born; the first was destined to rule the minor affairs of heaven, the second to rule over the eight hundredfold tides of the sea, and the third to rule over the earth. The latter one was created of full age and had a beard eight spans long! But he cried so much that Izanagi became disgusted with him and drove him out. Not long after this, Izanagi, having accomplished his mission, and knowing that his spirit-life was about to suffer change, built himself an abode of gloom on the Island of Ahaji, where he dwelt forever in silence and concealment.

All these things came to pass in the early part of the "Age of the Gods." Many centuries passed in which gods alone dwelt upon the earth. But at last the greatest event in all the history of Japan was to take place. The first real Emperor was born, and he was a child of the gods. His father was the "Heavenly Grandchild," and his mother was the fair daughter of the Sea God. From that memorable day to this the Emperors have descended in one unbroken line, and the veneration in which the Japanese Emperor is held is as old as the nation itself.

THE OLDEST WRITTEN STORIES

This Japanese myth, like the one which follows, is from the Far East, and both are taken from the ancient books of the world. Our first creation myth, of the Crow Indians, was taken directly from the lips of old Crow story tellers. These Eastern stories were handed down in that same way at first, and are told by Eastern story tellers now; but they were also written down hundreds and hundreds of years ago in the sacred books of each people. This was before or at about the same time that our Bible was being put for the first time into written form. Very lately these sacred books have been translated into English, and so we can read these perhaps oldest of all written stories.

CREATION STORY OF THE PARSIS

THE Parsis lived in ancient Persia and in India. This is the story of the creation of the world as it is written in their sacred book, called the *Zend-Avesta.*

Ahura Mazda, their supreme god, created the world in six periods; he successively made the heavens, the water, the earth, the plants, the animals, and man. Every time he made a good country, Angra Mainyu, the evil spirit, created a plague that spoiled it. Ahura Mazda tells to man how it happened that all these evils came into the world. He says:

"I have made every land dear to its people, even though it had no charms whatever in it. The first of the good lands and countries which I, Ahura Mazda, created, was the Airyana Vaego.

"Thereupon came Angra Mainyu, who is all death, and he counter-created the serpent in the river and winter. There are ten winter months there, two summer months; and those are cold for the waters, cold for the earth, cold for the trees. Winter falls there, the worst of all plagues." (These, you see, are the very cold countries.)

SEVEN REGIONS OF THE UPPER WORLD

Mount Merou, the earth according to Indian mythology, with seven regions, the sun on top, and India in the middle.

"The second of the good lands and countries which I, Ahura Mazda, created, was the plain which the Sughdhas inhabit.

"Thereupon came Angra Mainyu, who is all death, and he counter-created the locust, which brings death unto cattle and plants.

THE EGYPTIAN IDEA OF THE WORLD

The universe a large box, earth with its continents and seas the bottom, with Egypt in the center; the sky stretched over it like an iron ceiling, from which star lamps hang on strong cables; four lofty peaks connected by mountain chains holding up this ceiling, and through the mountains a heavenly river flowing, on which the sun floats like a boat.

"The third of the good lands and countries which I, Ahura Mazda, created, was the strong, holy Mouru.

"Thereupon came Angra Mainyu, who is all death, and he counter-created plunder and sin.

"And the fourth of the good lands and countries which I, Ahura Mazda, created, was the beautiful Bakhdhi, with high-lifted banners.

"Thereupon came Angra Mainyu, who is all death, and he counter-created the ants and the ant-hills."

So Ahura Mazda goes on telling of sixteen beautiful lands that he created, and every time Angra Mainyu, who is all death, made a counter plague, which kept that from being the perfect land. But even after he had created sixteen, Ahura Mazda said, "There are still other lands and countries beautiful and deep, longing and asking for the good and bright."

Angra Mainyu was not going to spoil things forever. There has never yet been a fair land into which sin and evil and misfortune did not come. But the Parsis were sure that sometime

there would be. Ahura Mazda, the good god, was not discouraged. "There are still other lands," he said, and for these lands the Parsis lived and hoped even while they bore the sorrows and plagues brought on by Angra Mainyu.

NORSE MYTHS

THE myths of the Norsemen and Teutons are of especial interest because they are of sturdy type, like the race from which all our

ODIN

German, Scandinavian, and English peoples have come. These stories have come down to us in *Sagas*, often in verse, which were sung and told by Norse poet historians, and in two collections of *Eddas*, or sacred books, Snorri's Edda and Saemund's, so named from the men who were supposed to have collected them and put them into final written form.

These Teuton peoples lived in the cold Northland, with its grand and rugged scenery, its dense forests, its long winters with their brilliant northern lights, and its summers with bright blue skies and midnight sun. The wild forces of nature appealed strongly to them. It was no wonder that they set the forces of cold and darkness over against those of warmth and light, and pictured a perpetual strife between them. So we find that the death of summer was taken to mean the guilt of Höder (winter), who was led by the evil spirit Lodi to slay Baldur (summer). Odin, or Woden, the chief god, was thought to have two ravens, Thought and Memory, to perch on his shoulders and whisper wisdom into his ears. Thor (thunder) was the strong god, and fear of thunder is natural to northern peoples.

One myth tells this about Night and Day. A giant Norve had a daughter Nott (night) of very dark complexion, who bore Jord (earth) and Dagr (day). Allfather, giving Night and Day two horses and two cars or chariots, hoisted them up into the sky to drive over the earth in turn. Night rides first with her steed Heimfaxe (rime mane), which every morning at the end of his ride bedews the earth with foam from his bit (the dew or hoar frost).

Day's steed is Skinfaxe (shining mane), which as he goes spills light all over sky and earth.

NORSE IDEA OF HOW THE WORLD WAS MADE

In the beginning, according to the Northern Sagas and Eddas, when there was as yet neither earth, nor sea, nor air, there was a powerful being called the "Allfather." He had no visible form; he was uncreated as well as unseen; and what he willed came to pass.

In the center of space there was, in this morning of time, a great bottomless deep, an abyss called "Ginungagap," dark and empty. Far to the north lay Niflheim, the abode of cold and darkness, a land of freezing mists, in the midst of which there was a perpetual spring. From this spring flowed twelve great rivers, whose waters froze as they flowed into the cold land, and made tremendous layers of ice which fell into the bottomless abyss, gradually filling it up.

Far to the south of the dark Ginungagap lay Muspelheim, the home of fire and light, where all was warmth and brightness. Its gates were guarded by Surtr, the giant of flame. He brandished continually his flaming sword, and sent forth great showers of sparks, which blew out over Ginungagap and fell with a loud hissing on the ice blocks dropped from the northern lands. Steam was formed which rose in clouds, met the cold winds from the north

and changed to hoar frost, filling up the great abyss.

THE GIANT YMIR

Thus heat and cold acted on each other till at last, probably by the will of the unseen, uncreated Allfather, they formed out of the hoar frost and mist a huge ice-cold giant, Ymir.

In early times,
When Ymir lived,
Was sand, nor sea,
Nor cooling wave;
No earth was found,
Nor heaven above;
One chaos all,
And nowhere grass.
— *Saemund's Edda.*

YMIR RISING OUT OF THE MIST

At almost the same time there was formed of wedded Frost and Fire a gigantic cow, Audhumbla (the nourisher), whose milk fed the

GOD OF THE SEA WINDS

giant Ymir. She, however, must have food if she were to give milk, and this food came to her from the ice, which she licked because it was salt. But as she licked these blocks of ice, they proved to contain gods. From the first lump, as she licked, there appeared first the hair of a god, and then the whole form of Bure (the producer). His three grandsons were Odin (spirit), Vili (will), and Ve (holiness).

WAR BETWEEN GODS AND GIANTS

Now there was war. For countless ages gods and giants strove. Bure and his three sons fought Ymir and killed him. Then, dragging his body into Ginungagap, they made of it the earth.

Of Ymir's flesh
Was earth created,
Of his blood the sea,
Of his bones the hills,
Of his hair trees and plants,
Of his skull the heavens,
And of his brows
The gentle powers
Formed Midgard for the sons of men;
But of his brain
The heavy clouds
Are all created.

To support the heavens, the gods stationed four strong dwarfs, Nordri, Sudri, Austri, and Westri, at the four corners of the overarching vault, and from them we get our names for the points of the compass, North, South, East, and West. To light the world, sparks from Muspelheim were set in the sky skull, to blaze as

MYTHICAL SEA MONSTERS

sun and moon or sparkle as stars. Then the sun was given his chariot and the moon his car, to ride forth with swift horses and god-drivers across the sky. A shield, *Svalin* (the cooler), was put in front of the sun-car, lest it burn both horses and Midgard, which was to be the abode of man, our earth. The chariot of Night was also appointed, Dawn came into being, and Thor, the thunder god, Evening, Midnight, and Morning, and all the Seasons.

But as evil was always present, following close on the heels of good, there came two wolves, Skoell and Hati, who chased after the moon and the sun, trying to swallow them up. Every little while they almost succeeded, and then there was an eclipse of sun or moon. But mortals on earth raised such a clatter with their wailing and beating on musical instruments that the wolves were frightened and let sun and moon go.

THE FIRST MAN AND WOMAN

Then came the first man and woman. Odin, Hoenir, and Lodur made them out of two trees found by the seaside. They were named Ask and Embla. Odin gave them breath, Hoenir gave them feeling, and Lodur gave them shape and blood.

THE NINE WORLDS

There are nine worlds in the Norse mythical geography. The lowest is Niflheim, the highest Muspelheim, and between them is Midgard, or Mannaheim, the home of man. High above man's home is the home of the gods, Asaheim; at its center, the meeting place of the gods, Idavöll, and Odin's throne, whence he overlooks all the nine worlds. Beyond the ocean, which encircles the earth, is Jörunheim, home of the giants. Close above the earth is the dwelling place of the light elves, or fairies, L'osalfheim, and between it and Asaheim is Vanaheim, home of the sea gods. Downward from the earth is Svartal Faheim, a home of the swart or dark elves, and below this is Helbeim, the home of the dead.

In such a myth-world, with fourteen gods and twenty-six goddesses, the Norsemen lived and dreamed and fought. From Odin, or Woden, we get our Wednesday (Woden's-day); from Thor, the thunderer, our Thursday (Thor's-day); from Tyr our Tuesday; and from Frey our Friday. Baldur, the sun-god, was the most beautiful and beloved, and sun-worship gives us Sunday, as moon-worship does Monday; so that when we have added Saturn's-day (Saturday) we have a full-named week.

Whole books have come down to us with stories of the happenings in this Norse myth-world, with its gods and goddesses, giants, dwarfs, elves, and fairies.

INTERIOR OF VESUVIUS, FROM A PHOTOGRAPH TAKEN JUST AFTER A VIOLENT ERUPTION, SHOWING HOT LAVA AND CLOUDS OF STEAM

THE EARTH A WONDERBOOK

HOW WISE MEN EXPLAIN SOME OF THE WORLD'S WONDERS

THE earth is as much a wonderbook to us as it was to the ancients, though in a different way. They sought to account for it by stories, strange tales of gods who stirred in their sleep and caused earthquakes, or breathed forth mighty blasts of flame and made volcanoes. These stories were the ways they had of expressing their sense of awe and of powerlessness before the mighty forces of Nature.

We think we understand the earth better. Men have learned in thirty or forty centuries many of Nature's laws. But the wonder is never taken away; rather it is deepened. The more we know of the tremendous forces at work inside and outside our earth, and of the marvelous balance in which they all work together, the more we are filled with awe and admiration. To say that a volcano must have a god under it, else how could it send out fire, was to confess that it was a miracle, something beyond human understanding or explanation. But to say that a volcano is probably a tiny sign of a whole earth on fire inside, with only a hard outer crust a few miles thick protecting us from its terrible heat, is not that more wonderful?

Let us come to this earth book in the spirit of the myth makers, seeing the marvelous things all about us and trying to explain them, and in the spirit also of the true scientist who, after he has searched as far as he can into its mysteries, still pauses in reverence and admiration before the mighty universe of which he is so small a part.

VOLCANOES

WITHIN the borders of the United States we have at present very little experience of active volcanoes. There is, to be sure, a "fire belt" stretching along our western coast, extending from Tierra del Fuego, or the "Land of Fire," the group of islands at the extreme end of South America, up along the Pacific coast and Alaska to the Arctic circle. But the volcanoes in our own country, Shasta, Hood, Rainier, and Baker, of the Cascade and Coast ranges, are either dead or faintly active. With the experience of having as a near neighbor a mountain on fire, with clouds of steam, ashes, and stones pouring out of the top, red-hot rivers of lava running down its sides, and terrible rumblings and roarings accompanying each eruption, Americans are happily unfamiliar.

THE HOMES OF FIRE GODS

The Greeks and Romans lived in one of the great fire belts of the world, the belt that

encircles the entire globe. It is from the Greeks and Romans that we get our name "volcano."

Etna and Vesuvius were their most active volcanoes, of which they had frequent and fearful reminders. It is little wonder that the gods of fire were to them among the most terrible and yet most familiar of their deities. One legend told of the mighty Typhœus, hundred-headed giant with flashing eyes, whom Zeus had conquered with a thunderbolt and buried under Mount Etna. The most famous story made Etna the home of Hephæstus, god of all fire. Hephæstus was lame, but very strong and powerful. He was kept always busy in his mountain workshop, toiling at his forge, with the one-eyed Cyclopes for forge men, making thunderbolts for Zeus, the ruler of heaven. Later on the Romans took Hephæstus for their own and named him Vulcan. V*u*lcan-o has become v*o*lcano in English. So every time we speak of a volcano we are going back to the old fire-god legend of three thousand years ago.

WHAT IS A VOLCANO?

What is a volcano? A burning mountain, you say; a mountain or hill, usually more or less cone-shaped in form, from which lava, cinders, steam, sulphur gases, and the like are thrown out, says the dictionary. What is the difference? The scientists refuse to let you call the volcano a burning mountain because, though it is a mountain, if by that we mean simply a mass of earth, rock, or other matter rising above the ordinary level of the country, it is not a solid rock or earth mountain set on fire and gradually being burned. At birth a volcano is not a mountain at all, but an opening or channel connecting deep underground parts of the earth with the surface. It may come to look from a distance like any other mountain, but it started quite differently.

HOW A VOLCANO MAKES ITSELF

Nearly all volcanoes build themselves from the bottom. And this is usually the way they do it: A few miles below the surface of the earth it is hot enough to melt any known rock; doubtless the melted or molten rocks are flowing in thick, white-hot masses; water finds them and turns into steam, which, together with the gases pent up there, results in a gigantic force seeking to escape. The explosive force of steam is well known. The bursting of an ordinary boiler, if you could imagine it multiplied millions of times, would give a good idea of the commotion going on inside the earth. The inner disturbance shakes our solid ground and causes it to fall or rise, sometimes to crack open. "An earthquake!" we cry. Then somewhere, from a rent or gap made in the surface, steam, gases, and heated rocks rush madly. The terrible power so long held in check flings the material high into the air, as a loaded cannon would throw a ball. When the mixture falls, millions of tons of rock, ashes, and volcanic mud pile up around the fiery hole in the ground, which becomes the chimney in the huge cone-shaped heap now called a volcano. If such an eruption takes place under the sea it often sends up a new island, which may remain permanently, or disappear as unexpectedly as it came. An island of this description was born in 1831, south of Sicily, and vanished after a few months.

THE MOUTH OF THE VOLCANO

From a distance, mountains of volcanic formation can be recognized by their cone-shaped appearance. As you come nearer to a volcano, or climb to its top, you will find that it is as if the point of the cone were cut off. Other mountains end in peaks or ridges or mounds. At the top of the volcano there is a depression, a great hollow, like an empty bowl. The name for this hollow comes from the Latin word for bowl, *crater*, which in its turn comes from Greek and Sanscrit words, to mix or to cook. This is the crater of the volcano, and a great mixing bowl it is, if the volcano is alive and in full action. It is the mouth of the volcanic channel, through which its burning contents are poured out. Let us take a look, through the eyes of a famous geologist, Mr. Whymper, into the crater of Cotopaxi, in South America.

A LOOK INTO A CRATER

"An amphitheater 2,300 feet in diameter from north to south, and 1,650 feet from east to west,

A SECTION OF HISTORIC ETNA, SHOWING HOW VOLCANOES ARE FORMED

with a rugged and irregular crust, notched and cracked; surrounded by cliffs, by perpendicular, and even overhanging, precipices, mixed with steep slopes — some bearing snow, and others apparently encrusted with sulphur! Cavernous recesses belched forth smoke; the sides of the cracks in the surrounding slopes. At intervals of about half an hour the volcano regularly blew off steam. It rose in jets with great violence from the bottom of the crater, and boiled over the lip, continually enveloping us. The noise on these occasions resembled that

THE VOLCANO, MT. VESUVIUS, IN ERUPTION

This snapshot of the crater, taken by the photographer of the "Illustrated London News," shows the corona of smoke at the bottom. The pointed summit of Vesuvius, long familiar in pictures, has been flattened and rounded, and the beautiful sugar-loaf cone is no longer to be seen. Vesuvius has been known as active since 79, when Pompeii was buried in volcanic ashes.

cracks and chasms, no more than halfway down, shone with ruddy light; and so it continued on all sides right down to the bottom, precipice alternating with slope, and the fiery fissures becoming more numerous as the bottom was approached. At the bottom, probably 1,200 feet below us, and towards the center, there was a rudely circular spot, about one tenth of the diameter of the crater, the pipe of the volcano, its channel of communication with lower regions, filled with incandescent if not molten lava, glowing and burning; with flames traveling to and fro over its surface, and scintillations scattering as from a wood fire; lighted by tongues of flickering flame, which issued from which we hear when a large ocean steamer is blowing off steam."

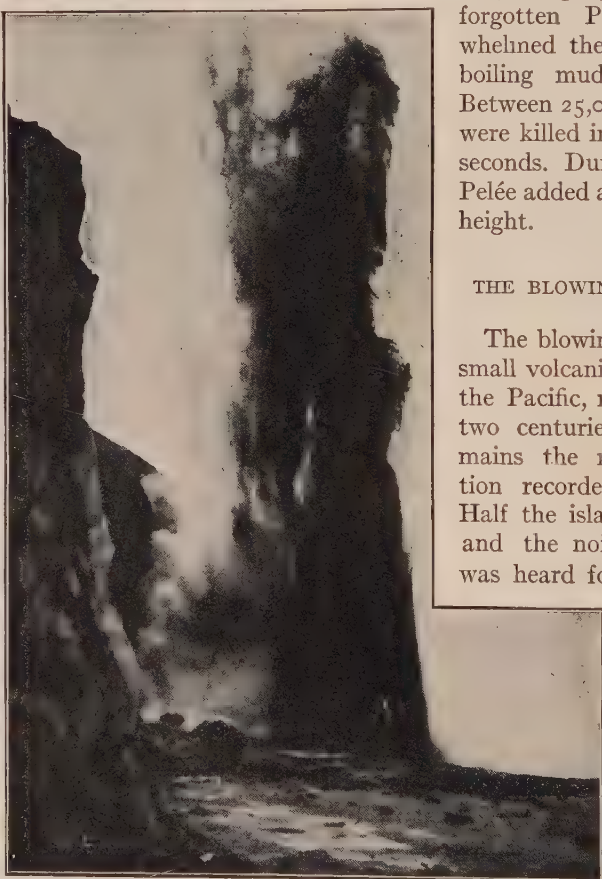
THE ERUPTION OF VESUVIUS

Volcanoes are dangerous in that they may appear dead for a long period and then flame into fearful activity. The eruption of Vesuvius in 79 A. D. was of this character. Up to that time the people living in that region were not aware that Vesuvius held any danger for them. Unafraid, they built their homes and tilled their fine farms and vineyards over the quiet sides of the slumbering volcano, then called Monte Somma. In fact, they did not believe

that the mountain was a volcano. Even repeated earthquake rumblings, which took place as early as the year 63, did not disturb their confidence in Monte Somma. Then, one August noon, a huge black cloud rose from the crater of Vesuvius, and filled the air with dust and ashes. Blocks of stone fell all over the country round. Lightning and thunder flashed and rumbled. The sea was lashed to fury. For almost two days the eruption lasted, and covered the country within a radius of fifteen miles with white ashes that looked like deep snow. Three cities, Herculaneum, Pompeii, and Stabiæ, were buried under a flood of volcanic mud and cinders. One man, who is called the Younger Pliny, saw the catastrophe from a safe distance, and described it in letters that we may read to-day. His uncle, a famous naturalist of the time, known as the Elder Pliny, lost his life while studying the volcano's eruption.

In our day men have dug out Pompeii, and are now digging out Herculaneum, finding that these buried cities can show us very plainly what kind of houses people had and how they lived in the first century, just as by studying the buried fossils we can guess, though not so surely, how the world looked thousands of years ago.

This eruption of Vesuvius also did large damage to the volcano itself. Half the crater wall was blown to pieces. The present cone is a new one. Since that fatal August day, Vesuvius has repeatedly shown itself an enemy to mankind. Again and again it has covered the neighboring regions with deep blankets of ashes and lava. In 1631 there was a fierce outbreak, ruining several towns and taking toll of about 18,000 lives. For a long time this volcano has been in a state of perpetual excitement on a small scale, and an observatory has been built near the top for the study of these disturbances.



TAÄL VOLCANO, WHOSE ERUPTION COST THE LIVES OF FOURTEEN HUNDRED FILIPINOS

MONT PELÉE

On May 8, 1902, the outbursts of Vesuvius were equaled by Mont Pelée in Martinique, when the beautiful city of St. Pierre was blotted out. Just as the people of Pompeii and Herculaneum looked upon Monte Somma as harmless, the people of St. Pierre had forgotten Pelée until it overwhelmed them with a torrent of boiling mud and heated rocks. Between 25,000 and 30,000 persons were killed in the space of several seconds. During its outburst Mont Pelée added about 2,000 feet to its height.

THE BLOWING UP OF KRAKATOA

The blowing up, in 1883, of the small volcanic island Krakatoa, in the Pacific, near Java, came after two centuries of quiet, and remains the most appalling eruption recorded in modern times. Half the island was blown away, and the noise of the explosion was heard for hundreds of miles. Volcanic dust rose and fell at great distances, and some of the finest particles hung in the sky for months, producing strikingly beautiful sunset effects in various quarters of the world. The Krakatoa eruption

created a giant ocean wave that reached a height of 100 feet. It swept over near-by land, and drowned 35,000 natives. This wave also carried a ship inland a distance of a mile and a half, tossed coral blocks weighing as much as fifty tons three miles from shore, and traveled the breadth of the broad Pacific, to be felt and measured on the coasts of lands as far distant as Africa and California.

AN ERUPTION IN OUR OWN POSSESSIONS

On January 30, 1911, the Taäl volcano in the Philippines erupted with terrible violence, laid waste 142 square miles of surrounding country, and killed 1,400 people. Following is the account of William Couch, an engineer in the United States Army:

"With a mapping and surveying party I was camped at Bayuyungan, Batangas, on January 28, 1911, when the Taäl volcano went into a state of eruption. The camp was located about four miles northwest of the crater, and about a quarter of a mile from the shore of Lake Taäl. About 3 A. M., January 28, the volcano showed signs of eruption. There were severe reports caused by the explosion of gases above the crater, and an electrical display lighted up the heavens. Large volumes of smoke were pouring out of the crater, and were carried off to the southward by the wind. This condition lasted about three minutes. Earthquakes of more or less severity were felt throughout the dawn of January 28. Smoke issued from the crater and ashes fell in our camp all this day and the next. About 1 A. M., January 30, I was awakened by a loud rumbling noise. I got up and stepped outside of the tent. Looking across the lake in the vicinity of the volcano, I saw great volumes of black smoke pouring out of the crater, accompanied by heavy explosions, resembling heavy artillery in action, and electrical display. The smoke drifted over our camp, and there was a light fall of ashes. The explosions ceased, and thinking that the disturbance was at an end we again retired, and most of the men had gone to sleep, when the loud rumbling was again heard, and before I could get out of bed an explosion of indescribable severity took place.

"On getting out of the tent I saw that smoke was coming out of the crater in dense clouds. Thinking there was going to be an eruption, I awakened the sleeping men, and wanted to vacate the camp, but we finally concluded to remain. The rumbling noise grew louder and louder, and then came a heavy report. I then saw the mud issuing from the crater as a cloud. In a few seconds I saw this cloud drifting across the lake toward our camp. Our camp was then swept by a heavy wind, which broke the tent ropes and threw the tent into the air. This atmospheric disturbance threw me a distance of about fifteen feet.

"Then there was a rain of ashes, which fell to the depth of about eight inches. The air was oppressive, and we had to gasp for breath; this lasted about twenty seconds. Then there was a light, warm shower of rain, followed by another fall of ashes, which lasted about half a minute. After this there was a cold, heavy fall of rain that continued for about fifteen minutes.

"By this time a tidal wave from the lake had reached our camp, a distance of about a quarter of a mile, and we took to a small hill about fifty yards away to the north. The bamboo and underbrush on this hill were so twisted that we could not penetrate far, but we had reached a safe elevation, and waited for day to break. After daylight we returned to the site of our camp to recover what articles we could, but we found that everything had been washed away."

AN ALASKAN ERUPTION

In June, 1912, Katmai volcano, in southwestern Alaska, which had been generally believed to be extinct, unexpectedly burst into violent eruption and continued active for three days. Vast quantities of dust, lava, and stones were thrown into the air. So dense was the cloud cast into the sky that the people in the village of Kadiak, about one hundred miles away, were in total darkness for two days. All the crops of Kadiak were destroyed by the fall of ashes; the fishes in the sea and rivers were killed and all the water supplies poisoned.

Katmai is one of a long belt of volcanoes which extend for sixteen hundred miles. In

A BONFIRE KINDLED BY WATER

Above is shown one corner of "The Valley of Ten Thousand Smokes," a wonderful Alaskan region of volcanic activity, exhibiting results of a huge convulsion of which the eruption of Katmai was only one phase. Below is shown a bonfire kindled by water. "One of the fumaroles," says the man who took the photograph, "was so hot and dry that shavings burst into flame after being plunged for a moment into its hot water. Since this consisted of almost pure steam, that is, water, what we really did was to kindle a fire by poking a stick into the water." The temperature was nearly 1200° F.

HOUSE AT KADIAK RUINED BY AVALANCHE OF ASHES FROM HILLSIDE

Weight of ashes from hillside avalanche crushed in roof and almost filled the interior of this house. St. Paul, Kadiak, June 9, 1912. These Kadiak views are given by courtesy of the "National Geographic Magazine."

this belt no less than sixty active volcanoes are known, among them Mount Wrangell, whose huge dome reaches a height of fourteen thousand feet; Mount Shishaldin, a graceful peak, whose outlines rival the Japanese Fujiyama; and Bogoslof, whose suddenly appearing and as suddenly disappearing islands have startled mariners for the past hundred years.

WHERE VOLCANOES ARE FOUND

There are many hundreds of volcanoes on the earth, though the majority of them are considered dead. Most volcanoes are in or near the sea, especially along the coasts of the Pacific Ocean. Many form chains or groups of islands like the Philippines, the Hawaiian Islands, the Lesser Antilles, and the Aleutian Islands. Scores of well-known islands like the Azores, the Bermudas, Cape Verde, and St. Helena are nothing but tops of volcanoes thought to be dead. Dead volcanoes are also found in great numbers in many of our western states, in Central France, and on the lower west bank of the Rhine. Even Great Britain bears traces of great volcanic disturbances. Nor is the earth the only planet to carry these scars. You remember that the dark places on the moon are the craters of tremendous burnt-out volcanoes. The island of Hawaii is one immense volcanic mountain 30,000 feet from the bottom of the sea, with about one-half of its body out of the water. Magnificent Mount Shasta in California rises to a height of 14,380 feet. Three others in our hemisphere are notably huge: Chimborazo and Cotopaxi in South America are 20,000 and 19,600 feet above the sea; Popocatepetl in Mexico is 17,887 feet in height. All of these great cones wear snow caps which dazzle the beholder, and make him slow to believe that these snowy heads might at any time turn into roaring furnaces that would destroy life and the country for miles around.

KINDS OF VOLCANOES

Peculiarities of volcanoes are worth noting and remembering. Thus Vesuvius is an excellent type of the kind that shatters its original cone and builds another; while Etna is remarkable for breaking out into a family of little cones which cluster upon the slope of the main vent. Shasta stands as a beautiful example of a great snow-wreathed, extinct volcano. The craters of Mauna Loa and Kilauea, in Hawaii, are famed for their lakes of boiling lava, which every seven years or so overflow and move down to the sea in rivers as wide as two or three miles, and thirty or forty miles in length.

LAVA LAKES, STREAMS, AND FIELDS

Lava is the melted rock which is thrown out through the volcanic channels. When it comes out through the crater mouth, we can look down into the crater and see what appears like a lake of smoldering fire. One of the most wonderful lava lakes in the world is that in the crater of Kilauea on the island of Hawaii. It is less than three miles across, and lies from six hundred to nine hundred feet below the rim of the crater. The surface of this sea of fire is usually covered by a thick crust, but here and there the red lava waves spurt up. Jets of vapor whistle and hiss as they escape, darting out showers of burning cinders, and forming cones of ashes on the crust sixty to one hundred feet in height.

The level of the fire lake of Kilauea is always changing. A fresh supply is ever forcing itself into the huge caldron, which now and then overflows. In 1840 the crater was full to the brink, when a crack suddenly opened in the side of the mountain; it sent forth a stream of lava thirty-seven miles long and sixteen miles wide clear down to the sea. At one point of its journey it poured down a cliff fifty feet high. Picture a red-hot stream forming a cataract as high as a house! When first thrown out the lava is altogether fluid and flows rapidly; sometimes, on steep slopes, faster than a horse can gallop. But the speed of the molten stone soon slackens, and the dazzling flood is covered by a brown or red crust called *scoriæ*, or volcanic cinders. When this crust has become a few inches thick, one may safely venture upon it, as one would on ice formed over a sheet of water.

Courtesy of National Geographic Magazine. Copyright, 1913

FRAME STRUCTURE, CRUSHED BY WEIGHT OF ASHES AT KADIAK, ALASKA

A United States revenue cutter was in the harbor at Kadiak at the time of eruption, and its officers reported the effects at that distance. When the utmost suffering is caused by a rain of ashes and stone which buries houses a hundred miles from the source of the disturbance, it is almost beyond human imagination to picture what must have been taking place in the volcano itself. The photographs on page 122 give a hint of the wonders of "The Valley of Ten Thousand Smokes" as it has since been visited.

OLD LAVA BEDS, AND WHY THEY ARE ALWAYS DANGEROUS

Lava keeps its heat, so that when a crust has once formed on its surface, heat escapes from the inside very gradually. Even after a lapse of three or four years a lava stream may be seen to steam in many places after a shower of rain, showing that the lower part of the mass is still warm.

Of the thousands of volcanic cones in the world, only about three hundred are known to be active. These are mostly near the sea. But the great volcanic disturbances of the past have left great lava floods. Some of these came out through the mountain craters, and others through great cracks in the earth's surface caused by underground activity. By these floods of melted rock, which flowed along valleys and wound around mountains, great sections of country were changed into lava beds. In the valley of the Snake and Columbia rivers, an area of at least two thousand square miles in Oregon, Idaho, and Washington became first a sea of hot, glowing rock, and then a huge lava-covered plateau. Now it is one of the richest wheat belts of the United States, for lava makes very rich soil. Yellowstone Park is a region of wonderful lava formations, where volcanic action long ago built up a fantastic area two thousand miles square, with acres of rocks of strange, unearthly shapes and coloring, and deep cañons and gorges of many hues.

KINDS OF LAVA

Lavas are of various kinds and colors. Perhaps pumice stone is the sort you know best. It resembles a sponge turned into rock. A lump of pumice will float on water. Large quantities of it drift down the Amazon River in South America, traveling often a distance of three thousand miles. And the Indians, living so far away from volcanoes that they do not know they exist, think that these floating stones are pieces of foam made solid.

A dark, heavy basaltic lava has built gigantic columns in many parts of the world. Popular belief has credited them to the handiwork of giants. The most notable example of this vast architecture is to be seen on the coast of Antrim, Ireland, where there are the summits of forty thousand prism-shaped columns, leveled pretty evenly by the waves of the sea. Some of the shafts of this famous Giant's Causeway are nearly four hundred feet in height.

EARTHQUAKES

WHEN THE GROUND SHUDDERS

THERE is nothing more terrible to man than to feel the earth shaking under his feet. Even if the tremor of the ground is very slight, and does little or no damage, it is a sign that the solid earth on which he lives his life, and builds his houses and railroads and cities, cannot always be counted on to remain firm and solid.

Our modern earthquake-reading instruments — *seismographs*, or "earthquake writings," as they are called — are so sensitive to the least vibrations of the earth's crust that they record many more of these tiny shocks than had ever been imagined before. Japan has hundreds of these shocks a year, and the people build their houses as light as possible, so that if they are thrown down the danger and loss will be lessened. In a single year, six hundred and thirty shocks were recorded in Japan.

WHAT CAUSES EARTHQUAKES

It has been well said that every kind of nature activity which produced our world can be seen going on in a small way now. Water is wearing away rock, heat and cold are contracting and expanding all kinds of solids, and gravitation is pulling everything towards the center of the earth. But in nothing is earth making being done on so large a scale as in the great volcano and earthquake belts. Here we see the disturbances taking place, which once made mountains and hills and valleys, sea basins and continents.

Earthquakes are caused by the slipping or warping of the earth's crust, which has been responsible for all the physical features of the globe. But where with us a one-inch slip of earth surface makes a very severe earthquake, and a six-inch slipping of a section is

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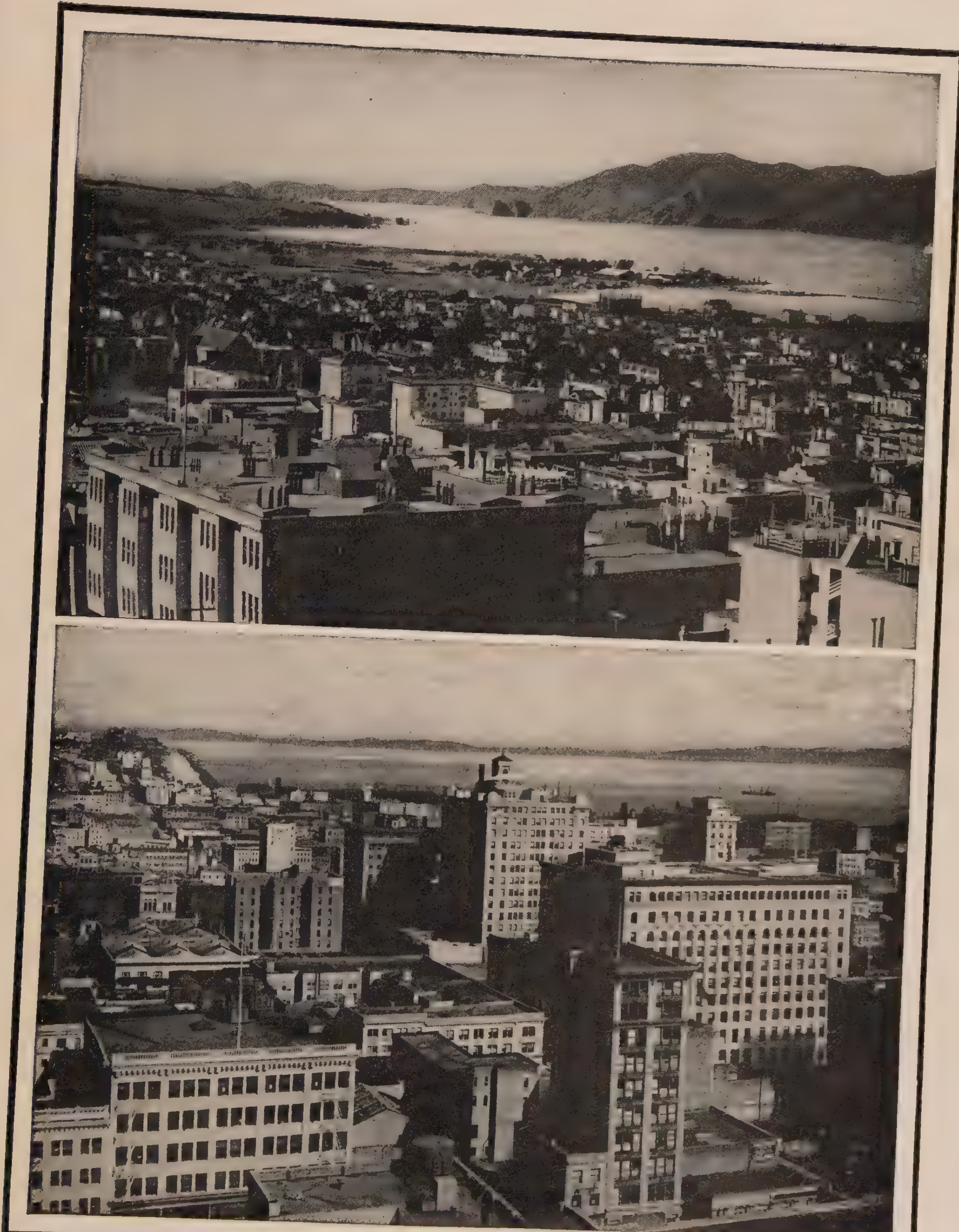
RUINS CAUSED BY THE FIRE THAT FOLLOWED THE EARTHQUAKE IN SAN FRANCISCO

Looking north from the corner of Mission and Fourth Streets. Ruins of the Pioneer Building, St. Francis Hotel in the distance.



THE REBUILT SAN FRANCISCO, A MARVEL OF SWIFT RECOVERY

The peninsula in the central background, San Francisco Bay, is the site of the Panama Exposition of 1915.

fearfully destructive of life and buildings, then there were tiltings and tippings of rocks through which no human beings could have lived.

An earthquake is caused by the passage of a wavelike movement through the crust of the globe; a shudder that springs from some inner change, like the shifting of giant masses of rock deep below the surface. Often it is but a slight trembling, hardly noticeable, and again it may be severe enough to shatter cities, and even swallow men, animals, and houses. The damage from earthquakes comes more from the vibration than from an actual shift of ground. Sometimes only a single shock is observed, and sometimes shocks may be repeated at uncertain intervals over a period of days or weeks. They are of more frequent occurrence than is realized, the crust of the earth being rarely free of some seismic disturbance.

THE CHARLESTON AND SAN FRANCISCO SHOCKS

Earthquakes occur generally in volcanic regions or where it is mountainous. But there have been remarkable exceptions to this rule. One of these was the calamity to Charleston, South Carolina, on August 31, 1886. One present gave the following account: "As the hour of 9.50 P. M. was reached, there was suddenly heard a rushing, roaring sound, compared by some to a train of cars at no great distance, by others to a clatter produced by two or more omnibuses moving at a rapid rate over a paved street, by still others to an escape of steam from a boiler. It was followed immediately by a thumping and beating of the earth underneath the houses, which rocked and swayed to and fro. Furniture was violently moved and dashed to the floor. Every movable thing was thrown into extraordinary convulsions." Not a building in Charleston escaped injury, and almost fourteen thousand chimneys were broken off the roofs. The ground was cracked in places to a depth of many feet, and from these cracks sand was thrown out in large quantities.

The San Francisco earthquake, April 18, 1906, was another of the great disasters of modern times. A one-minute shock, with resulting fire, was sufficient to destroy the business and downtown residence section, including 28,000 buildings, with property loss of $500,000,000. The city was rebuilt with fine new buildings, and the beautiful San Francisco of to-day is a monument to the energy and constructive vision of her people.

THE JAPAN DISASTER

One of the most destructive earthquakes of modern times occurred on September 1, 1923, in the eastern portion of Japan, covering a region of approximately 9,000 square miles and wrecking to a considerable degree the cities of Tokio and Yokohama. Fires in the cities and high waves along the coast added to the horrors of this wholesale destruction. It was estimated that 200,000 perished in the disaster, while the homeless numbered two million. In Tokio it was said that of 500,000 homes only 122,000 remained standing, while in Yokohama only 27,000 remained of 96,000. Business sections, foreign embassies, and harbor equipment were in many sections literally wiped out. The United States led in enormous relief contributions, and the people of Japan went about rebuilding their cities with a splendid courage.

This earthquake is believed by many scientists to be of the mountain-building, rather than the volcanic, type. Actual measurements show a drop of four feet, due to a strain in the earth's crust which finally caused the surface rupture.

SPEED OF EARTHQUAKES

Earthquake shocks travel at varying rates of speed, and experiments clearly show that the speed depends on the kind of rock or composition of earth through which the shudder passes. The velocity of the Charleston earthquake was marvelously rapid, — 17,008 feet a second. In Japan, earthquakes have been known to travel at about 5,100, 8,000, and 9,800 feet a second, while other records, made in Italy, show the rate as low as 650 feet a second.

The most unstable belt in the world is that encircling the Pacific Ocean. This includes Japan, many of the Pacific islands, the South American earthquake region, and our own Pacific coast. The other great zone borders the Mediterranean and Caribbean seas, and goes through Central Asia.

THE OLD MAN OF THE MOUNTAIN, FRANCONIA NOTCH, NEW HAMPSHIRE

THE SIERRAS AS SEEN FROM REDLANDS, CALIFORNIA

THE MOUNTAINS

" . . . But breathe the air of mountains
And their unapproachable summits
Will lift thee to the level of themselves."

EACH of the five continents has its mountain groups or chains, which make the strong backbone for the plains that slope to the rivers or to the sea. These mountains have had a great deal of influence on the world's history. They separate countries, shutting off one nationality from easy communication with another. They affect character, so that you find something of the strength of the hills in the mountain peoples. They change climate, standing as barriers to temper cold winds from the north, and cool the hot blasts that come up from the south. More than all else, they are great collectors and distributors of water. Not only do the great rivers of the world have their sources high in these mountain ranges, but their forests hold and protect the waters which are taken from the air in rain and snow and fog. The problem of conservation, now so much discussed in this country, is the question of how to save our forests for the sake of the protection they give to our great water courses. These in their turn make our lowlands rich and fertile, when otherwise they would be barren deserts.

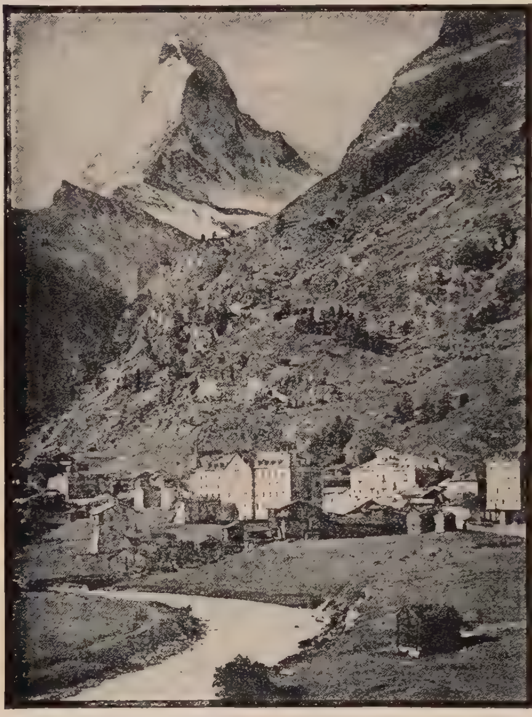
MAN'S THOUGHT OF MOUNTAINS

When we think of mountains, we usually think not of their location or of their uses, but of their grandeur and beauty. If we live near great mountains, they come to have personality to us. We watch them as our friends, and know their outlines and their shades and lights by heart, as Ernest, in Hawthorne's story, knew the Great Stone Face in the Franconia Notch of the White Mountains. A mountain is never twice the same. Some days it will be clear and bright, again it will be wrapped in garments of mist, from which only the lower part stands out in even, shadowy outline. But always the mountains are majestic and unapproachable; always they give man a sense of a might and strength far beyond himself. "The strength of the hills is His also."

So it was little wonder that in the childhood of the world men thought of mountains as the handiwork of the gods, who had either hurled them from heaven or built them to hold up the skies. When the gods had built them they would naturally use them as their earth homes. So imaginary Mount Merou was the throne of the gods of India as far back as man could trace. The peak of Lefeu in China, and the volcano of Fujiyama in Japan, are also sacred mountains. The Samanala, or Adam's Peak, in Ceylon, is reverenced as the spot where Buddha left his last footprint before he soared to heaven; and also as the place where Adam, barred out of Paradise, came to do penance. To the Armenians, Mount Ararat is a holy place. Olympus was the dwelling place of the gods of Greece; Parnassus of the Muses; and so we might go on with a list of sacred mountains of every land.

Certain peaks all over the world have especial interest, either because of their associations, or because of their unusual height. Mount McKinley, the highest peak in North America,

towering 20,500 feet above sea-level, is familiar to us because of the many attempts during the



ZERMATT AND THE MATTERHORN

last ten years to climb to its summit. We have a feeling of possession in our Rocky Mountains with their great national parks. It is a matter of national and continental pride that we need not go outside of the American and Canadian Rockies for some of the most majestic scenery in the world, while the Grand Cañon, the Yosemite, and the Yellowstone give unsurpassed scenic effects both of color and grandeur.

WILLIAM TELL'S LAND

Switzerland is, of course, the most famous mountain country. Situated in the heart of Europe, it is easily reached. It is picturesque beyond most mountain regions, because people live very high on the peaks. The Swiss have built their low-roofed chalets under overhanging cliffs and upon the high Alpine meadows. Switzerland shows every form of rock architecture, from the rugged tower of the Matterhorn to the great snow-capped dome of the Jungfrau and her sister peaks, and the lofty Monte Rosa, 15,217 feet high.

THE GREAT MOUNTAIN RANGES

From our earth story we have seen how mountains were made. Just why these great rock ridges were thrown up from within the earth in their present lines, we do not know. Because great chains of peaks border our coasts, anywhere from fifty to five hundred miles from the shore, geologists have thought that these were perhaps the original boundaries of the continents, and that the later volcanic belts are of a much more recent period. If this be true, the Rocky Mountain range would have been in prehistoric times our western border, and the Pacific coast, with its volcanoes and earthquakes, would be "new land."

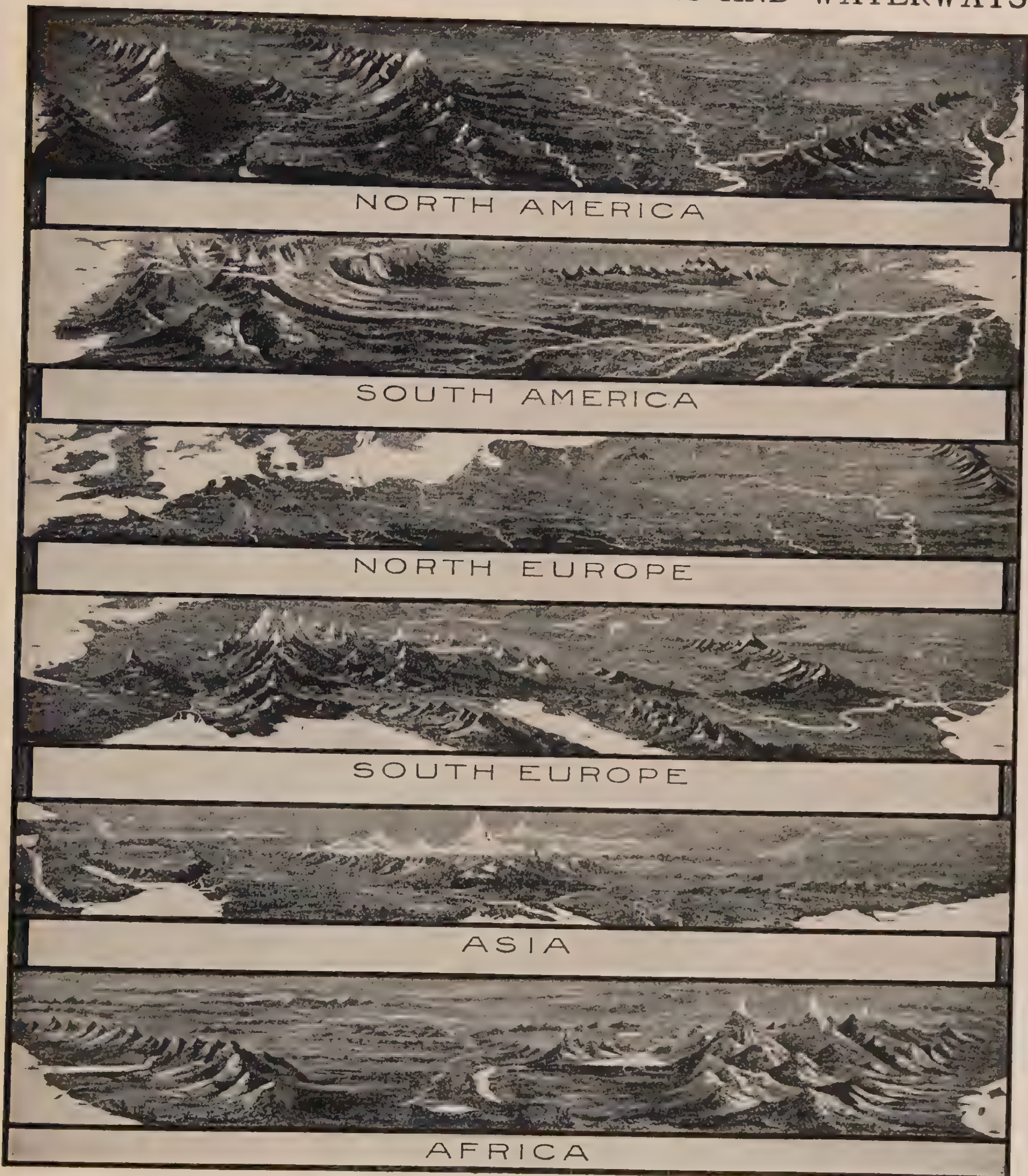
Many ranges, but not all, run from north to south. Others extend from the land into the sea, making peninsulas, like Lower California and Italy. Still others, like the New Zealand and Hawaiian Islands, rise in the middle of the ocean. The continents owe their triangular shape to their mountain chains, which run from north to south, gradually coming together at the lower points.

As you look at the relief pictures of the continents you will notice that, besides the

HIGHEST POINT OF VIEW ON THE RAILWAY THROUGH THE ALPS

main ranges, there are secondary ranges, which are shorter and lower than the great chains which give the continents their shapes. The

CONTINENTAL MOUNTAIN FORMATIONS AND WATERWAYS



EXPLANATION OF THE RELIEF MAPS OF THE CONTINENTS

1. Pacific slope; Sierras; Rockies; Plains and Mississippi Valley; Alleghanies; Atlantic coast.
2. Pacific slope; Andes; Long eastern slope; Amazon River; Parima Mountains; Atlantic coast.
3. British Isles; North Sea; Denmark; Baltic; North Germany; Russia; Ural Mountains.
4. France; Mediterranean; Alps; Italy; Adriatic; Danube; Carpathians; Bulgaria; Black Sea.
5. Red Sea; Arabia; Persian Gulf; Ganges; Himalayas; Burma; China; Yangtze; Yellow Sea.
6. Atlantic; Congo; Coast Range; Lake Lincoln; Central Africa; Lake Albert; East Coast Range; Indian Ocean.

highest mountains of the world are in the principal ranges of each continent: in the Rockies in North America, the Andes in South America, the Alps in Europe, the Himalayas in Asia, and the extensive chains of Africa and Australia.

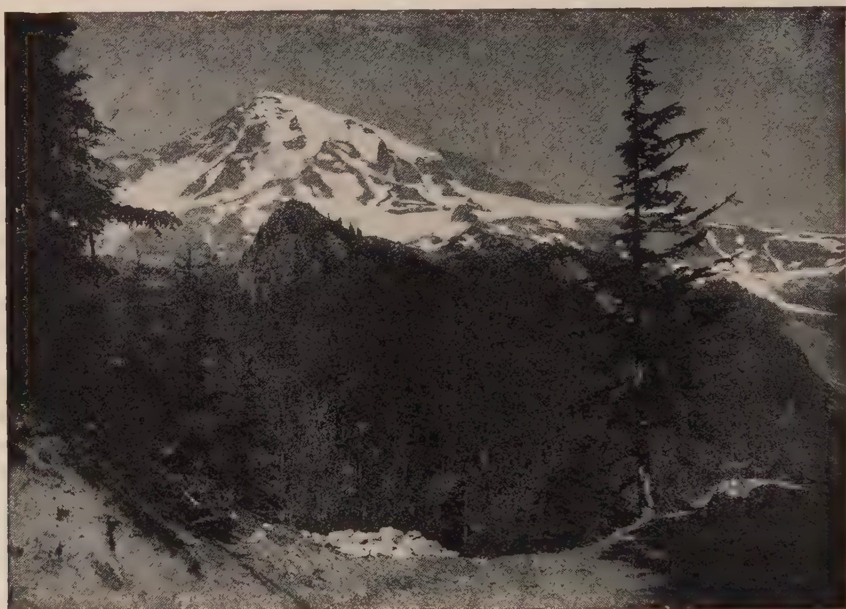
AT THE TOP OF THE WORLD

Switzerland is the region about which poets have written and singers have sung, but it is not the highest part of the world. To find that, we must go to Central Asia, to the plateau of Pamir, which has been called "the roof of the world." Here three great mountain chains take their beginning. This triple wall of Asia is about fifteen hundred miles long and six hundred miles wide. In each of the three chains the average height exceeds that of any other ridge in the world. Here, too, the three great rivers, the Indus, Ganges, and Brahmaputra, have their sources.

Of these three mountain chains the most famous is the Himalayan. Its tallest peak, Mount Everest, is 29,002 feet high, the highest mountain of the world. You will notice that it is nearly twice as high as Mont Blanc, and a third again as high as Mount McKinley in Alaska.

CLIMATES AND CLIMBING

With their base in the tropics and their head in the clouds, the Himalayas have at varying heights almost all the climates of the world. The lower valleys are filled with flowers and tropical growth; farther up the climate becomes more like the temperate zones of the world, and for the last two miles of their height, which are above the freezing line, there are the great snow fields and glaciers and ice formations which give the range its name, Himalaya, "the abode of snow."



SNOW-CAPPED MOUNT RAINIER, MONARCH OF WASHINGTON

Mountain climbing is opening up new regions in Asia, Africa, and South America, which have waited till the twentieth century for man's exploration; but we need not climb mountains to feel their grandeur. As we live near them, or travel to see them, we shall find that our first impression as well as our last is of awe and of reverence before this wonderful handiwork of God.

MTS. WILBUR AND MCDONALD, IN THE CANADIAN ROCKIES

Courtesy of National Geographic Magazine

THE MUSSULMAN IN THE DESERT

DESERTS

SCATTERED all over the world, but especially in the southern continents, there are great deserts, barren stretches of waste land where there is little or no vegetation. These are the unused sections of the globe. A few tribes of the East make their homes upon them, as you will see when you read about the Bedouins; but in general men do not live on these great dry plains.

WHAT MAKES A DESERT?

A desert is caused by absence of water. In some parts of the world rain falls so seldom that whole districts are practically rainless. Here we find the great deserts. In southern Peru there is a region where rain has not fallen in the last seven years. Many regions report an average rainfall of less than two inches in a year, and still more have from two inches to ten. These desert lands stretch in a wide belt both north and south of the equator, extending round the globe. Beginning in the Desert of Sahara in Africa, the "world's oven," as it has been called, the belt goes across by Arabia and Persia to Mongolia, then across the dry sections of Australia to the Desert of Atacama in South America. Not all the deserts of the world lie in this hot equator belt. Our own western states and many countries farther to the north and south of the equator have their smaller dry sections. These are usually walled in by mountains, which act as natural barriers to keep out the moisture which would otherwise blow over the plains and make them fertile. High ranges near the sea will often have beautiful green valleys on their outer slopes and barren stretches of sand within. Our high mountain chains on the Pacific coast are the chief cause of the desert region immediately east of them. They stop the winds from the ocean and leave the lands to the east dry and arid, until our modern systems of irrigation supply the thirsty land with the moisture needed to make it fertile.

Not only mountains but the heat of the sun keeps the lands near the equator dry. The trade winds which blow over these desert regions have so little moisture that they pick up all the water they can from the land beneath them. So in the world's great desert belt the winds are as likely to take away moisture as to bring it.

WHAT WE OWE TO WATER

We who live in the United States cannot easily appreciate what it would mean to live in the dry sections of the world. Our country owes much of its prosperity to its steady rainfall and the rich water supply stored in mountains and rivers. Air and water are two essentials to life. A man may live for a month without food, but he cannot exist a week without water.

In the East, water is so precious that it is sold on the streets. Women must go long distances to wells and carry laboriously to the homes the small supplies which they need. Perhaps no one cause is more responsible for the

differences between Occidental and Oriental life than the abundance of water in the West and its scarcity in the East.

THE DESERT LIKE THE OCEAN

Deserts have often been compared to the ocean, and in many ways they are not unlike. The wind tosses the waters of the ocean into waves, and the sands of the desert into great billowy dunes and ridges, which make it look from a distance like a vast white ocean. The waters and the sand are both, strange as it may seem, salt. The waters of the sea are about equally salt from pole to pole, while the sands of the desert vary in saltness. Both ocean and desert are closed basins, shut in by shore or mountains, with no natural outlets, and little to affect their surface save the air above them. And man, while he can travel across both, can make a permanent home on neither.

WHAT THE AIR DOES TO THE DESERTS

Air cannot protect the desert surface from the sun's rays, as it might if it were more moist and could temper the heat and light by banks of cloud. So the desert is very hot. Temperatures of one hundred and eighty degrees Fahrenheit have been reported from the deserts of Africa and Arabia. Because there are no clouds to hold the sun's heat, there is a remarkably sudden drop of temperature at sunset. Regions where the thermometer has stood at one hundred degrees and over for the greater part of the day will be so cold during the night that water will freeze. Many of our deserts were originally fertile lands, which became barren because of the absence of water on their surrounding mountains. That is why people fear so much the cutting away of forests from our great mountains. As the water ceased to be held by the trees and mountain streams, and the mountains stood out bare and rocky, the lowlands soon became dry and unfit for farming. Then clouds ceased to form in the highlands and float down over the plains; the hot sunlight beat down without ceasing, parching the land and disintegrating the rock, until at last there was only a trackless desert.

The most important stretch of desert land on the earth is the Sahara, which reaches across

THE SAND-SWEPT, ROCK-STREWN, GREAT DESERT OF ARABIA

Africa from the shores of the Atlantic to the Valley of the Nile. Imagine a vast waste of sand stretching three thousand miles across the United States, from Maine to California, and six hundred miles from Chicago on the north to Birmingham on the south, and you will get some idea of the extent of the Sahara. This desert was once the bottom of an ocean, as were most of our inland plains. While the average height of the Sahara is about two thousand feet above sea-level, in one place it is one hundred and sixty-five feet below, which shows that it might easily have been a deep ocean basin. Few deserts are the flat stretches of sand which we are accustomed to think them. In the midst of the Sahara there is a range of lofty mountains, snow-covered during part of the year, dividing the desert into two parts, on both sides of which are lines of lower shifting sand-hills. In the Gobi Desert of China, the eastern part of a great 1,850-mile sand plain, are cliffs which show the beating of ocean waves, wearing them away thousands of years ago, before the waters sank back into our ocean basins, and the land was left high and dry. In the Andes there are long plateaus which rise above one another between the sea and the highest mountains. The Atacama desert, the largest in South America, is a vast expanse of reddish-colored rocks, with blowing sands between.

TRAVELING HILLS

We think of deserts as sand plains, but they are not all level reaches of sand. In our own country there are great clay and rock formations, making the dry stretches look like cracked plains of concrete. There are fields of crystallized salt in Utah, and miles of sandstone and limestone in the Bad Lands of Wyoming; but the gradual wearing down by wind and weather has reduced many of the desert surfaces, and especially those of the south, to fine shifting sand, which the wind may toss where it will. Even on quiet days the wind is at work picking up these bits of sand and carrying them along. On windy days, or when one of the fearful wind storms comes on the desert,

SALT HEAPS GATHERED ON THE SHORE OF THE GREAT SALT LAKE IN UTAH
The water is so buoyant that one cannot sink in it, and swimming is a comical sight.

By courtesy of Travel

AT A DESERT OASIS

it will pick up a hill of sand and whirl it away, casting it down in a new place.

OASES

Fortunately for man, deserts are not unbroken stretches of sand. They are dotted here and there with beautiful green spots, where water gushes from springs or comes down from the mountains in streams, making a fair green island in the ocean of sand. Here date trees, apricots, peaches, and pomegranates may often be seen. Here man may find comfort and coolness in the heat of the day. Sometimes these oases come at irregular intervals, dotted over the plain. In the Desert of Sahara they form a line in the middle of the open section. So the traveler can pursue his journey across in a fairly straight path, with palm-waving stations every little while. Man has succeeded in boring wells in many places, too, and these spots have become groves and gardens, so that the desert has lost its terror.

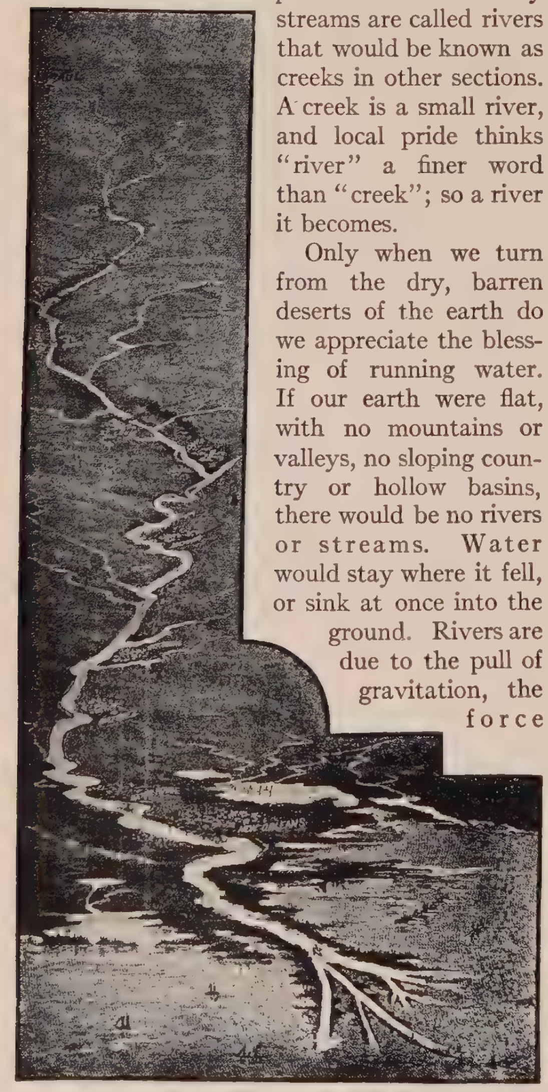
RIVERS

"RIVERS," says a great writer, "are the irrigators of the earth's surface, adding alike to the beauty of the landscape and the fertility of the soil; they carry off impurities and every sort of waste matter; and when of sufficient volume, they form the most available of all channels of communication with the interior of continents. . . . They have ever been things of vitality and beauty to the poet, and agents of comfort and civilization to all mankind."

WHAT IS A RIVER?

Everybody knows what a river is, of course. Well, what is it? When does a brooklet become a brook, a brook a creek, a creek a stream, and a stream a river? These things all seem simple enough until we really try to tell the difference in words. The dictionary will give you a definition. Let us see what a river is, in law. It is "a stream of water larger in volume

than a creek or brook, flowing in one direction constantly, or up and down with the tide, and discharging into a larger body of water." A river always runs down grade, even though the grade be slight, or else the water would not flow. High grades at some points make a pressure that carries the current along in more level spots. The river speed depends upon its slope and volume. Usually a number of brooks and creeks unite and make a volume of water sufficient to be regarded as a river. There is no fixed measurement, however, and in some portions of the country streams are called rivers that would be known as creeks in other sections. A creek is a small river, and local pride thinks "river" a finer word than "creek"; so a river it becomes.



THE MISSISSIPPI FROM ST. PAUL TO NEW ORLEANS

Only when we turn from the dry, barren deserts of the earth do we appreciate the blessing of running water. If our earth were flat, with no mountains or valleys, no sloping country or hollow basins, there would be no rivers or streams. Water would stay where it fell, or sink at once into the ground. Rivers are due to the pull of gravitation, the force which makes water always run down towards the lowest level it can find. If the earth were porous like a sponge, all the water would run right through the soil towards the center of the earth. But water cannot wait to soak through soil and rock. There is too much of it, and it is in too much of a hurry to get down. So it finds its way down the hills between the cracks and in the hollows, and gradually wears a bed for itself.

THE SHAPE OF A RIVER BED

If you were high enough above the earth in an airship, and could clearly see a vast expanse of land beneath you, you would get a wonderful picture of the way a river is fed by the various streams which flow into it. It would look like an immense tree laid out flat. The Rhine and the Mississippi might make you think of a majestic oak, while the outline of the Nile would put you in mind of a palm tree. Rills and brooks you would see as twigs, streams as branches, and the body of the river as the trunk of this watery tree.

Each of the great rivers of the world has a character all its own. It may be broad and calm, narrow and tempestuous, straight or crooked, full of rocks and waterfalls; or it may be shallow and muddy, or deep and blue.

FLOOD SEASONS

The amount of water in a river depends on the size of the region for whose waters it is the outlet. If this region be large, with many lakes and streams and steady rainfall, the river will be large. Some rivers are very even in their flow. The rainfall of their country is fairly steady, and the water is quickly and evenly distributed. But others are in regions where much water is stored during the winter in snow and ice on the mountains. In the spring this melts fast and floods the river till it flows out far over its banks. A heavy rain will turn a quiet mountain stream into a raging torrent. Where forests have been cut down on the slopes of the river basin there are likely to be floods. The rain is less likely to soak into the ground; there are no roots or trees to hinder its passage. So it flows easily down the dry sandy surface

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THE UPPER DANUBE

Here is shown in striking fashion the fertility that a river contributes to neighboring soil. The thrifty Germans make the most of every foot of this rich area.

and sweeps on over the plains below. Wooded slopes are one of the best forms of insurance which a nation can carry against destructive floods.

The first move of settlers in a new country is to clear the land of timber. This enterprise is undertaken partly for the sake of agriculture and partly for the harvesting of a crop of timber for building purposes and for fuel which will bring quick returns to the settler. Unfortunately the process is always carried on too long, and there comes a time in the history of every nation when it must turn its attention seriously to the problem of conserving and restoring its forests. In this twentieth century the United States has come to a partial realization of the dangers of denuding its surfaces of their natural covering of trees. Not only is the Government taking hold of the matter through its able and efficient Forestry Service, but states and organizations of private individuals are making careful surveys and instituting campaigns for local tree planting. Should we need an incentive, we need only turn to the reports of experts who have studied the effects of deforestation in other lands. "The reckless and wanton destruction of forests has ruined some of the richest countries on earth," writes one traveler. "Forests have an immense effect on climate," says the English observer, Sir Ray Lankester, "causing humidity, and similarly causing moderate and persistent instead of torrential streams. Spain has been irretrievably injured by the cutting down of her forests in the course of a few hundred years. The same thing is going on to a disastrous extent in parts of the United States. Whole provinces of the Tibetan borders of China have been converted into uninhabitable sandy deserts, which centuries ago were fertile and well watered and supported rich cities, apparently in consequence of the reckless destruction of forests."

Forestry has been defined as "the economic management of trees as communities." There can be no doubt that a "community of trees" conserves moisture. The ground which is protected from the intense heat of the sun's direct rays holds water and stores it. If water can seep down into the river channel gradually, there will be less likelihood of a sudden torrent on the mountainside which would rush down

FATHER NILE, FROM A FAMOUS SCULPTURE

and make the river at the bottom overflow its banks.

THE FLOODS OF THE NILE

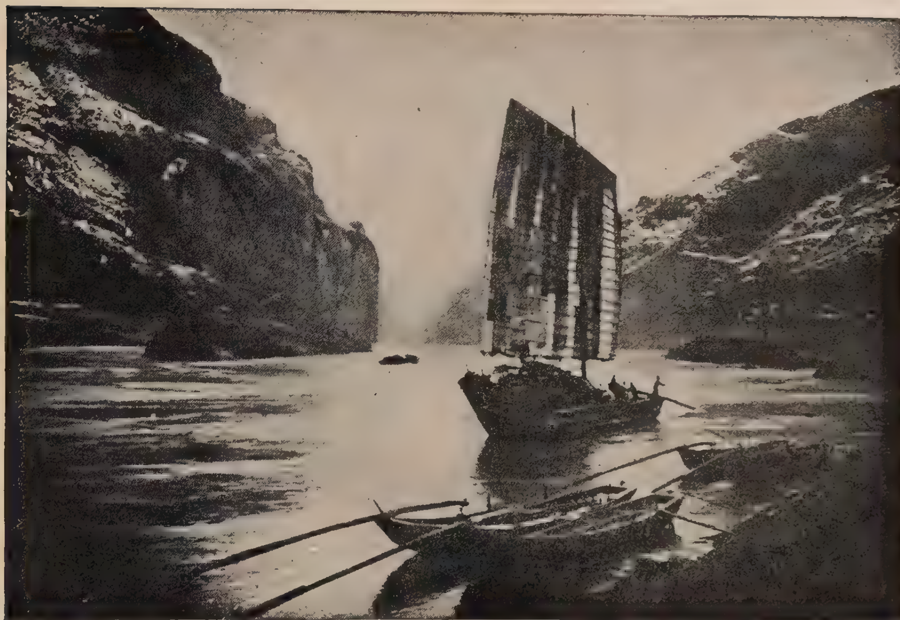
We are apt to think of floods as a calamity, sweeping away homes and destroying crops. But in some of the less well-watered parts of the world they are a great blessing. In Egypt, after a long dry season the Nile begins to rise, flooding over two thousand square miles of land, and leaving behind, when its waters drop back to their regular channel, a fertile valley covered by a rich, thick, black mud in the place of a barren desert. The annual rise of the Nile is from thirty-eight to forty feet, and comes in the summer months.

The Egyptians worshiped the Nile as a sacred river, which gave yearly to those who dwelt on its banks this wonderful gift. Father Nile was a kindly god who brought them blessings of fruit and flowers.

The reason for this yearly flood was a mystery to them, but in our own day it has been found that this forty-foot rise of the waters is due to the melting of snow on the mountains of Ethiopia, where the Nile has its source, more than four thousand miles away from its mouth on the Mediterranean.

THE SWIFTLY FLOWING JORDAN

A traveler once said that there may be something on the surface of some other planet to match the Jordan, but there is nothing on this, and we may believe it when we consider that this river extends only about 115 miles in a straight line and has a fall of 3,000 feet. The word "Jordan" is a Hebrew word, and means "that which goes down," or "descender." But this is not the only peculiar thing about this remarkable river. It receives its supply of water from three never failing springs on the cool, green slopes of Mount Hermon, the highest peak in Palestine, and flows down through a deep gorge into the hottest, driest,



OX LIVER GORGE AND RAPIDS ON THE YANGTZE RIVER, WEST CHINA

and lowest depression on the face of the earth. It twists and turns so much that its actual distance is about 250 miles. It flows through two bodies of water — Lake Huleh and the Sea of Galilee. Just below Lake Huleh the river reaches sea-level, and then, in a distance of less than ten miles, it fairly tumbles down in cascades and whirlpools, and flows furiously into the Sea of Galilee, nearly 700 feet below sea-level. It is said that it flows with such force that it passes through the lake in a straight line without mingling with its waters. Outside of the Jordan valley there is no place on the earth's surface so low as the Sea of Galilee, but in the southern part of Palestine lies the Dead Sea, 600 feet lower. And through a wild, deep gorge, lined with tangled jungle or chalky cliffs, the Jordan still goes down, and pours into the Dead Sea 6,500,000 tons of water daily. The river itself swarms with fish, the banks are musical with the song of birds, and wild beasts lurk in the thickets.

Explorers have tried to sail down this tumbling river, but have never been able to get through. A short distance above the Dead Sea, near the ancient city of Jericho, is a shallow ford in the river, where thousands of pilgrims go every year to bathe in its sacred waters, for the Jordan has always been a sacred stream both to Hebrews and Christians, and its shores have been the scene of many historical events, endeared to millions of people the world over.

CHINA'S RIVERS

China has two great rivers — the Yangtze (meaning "Son of the Sea"), which is the largest of the country, about 3,500 miles long; and the Hwang-ho, or Yellow River, which, though 1,200 miles shorter than the Yangtze, is known for the harm its floods have done. Unlike the kindly Nile, its floods bring death instead of life. Hence it has been called "China's Sorrow" and "The Scourge of the Sons of Han." In 1877 the Hwang-ho burst over its banks and drowned nearly a million natives. In 1898 it overwhelmed 1,500 villages. But the Chinese are finally conquering this river by providing a chain of canals into which the raging torrents of water may be turned and made use of in irrigating the land. The Yangtze is a river of more even flow, and is the chief commercial waterway of China. It is famous for its rapids and gorges, which make the westward

passage dangerous and often impossible in the rainy season. Both these streams have their sources in the Himalaya region; both run in a vast semicircular line, first in opposite directions, then meeting to flow together to the sea through an enormous delta, or group of mouths, 96,000 square miles in extent. This delta was built by the mud which the Hwang-ho constantly carries down from mountain and plateau. It has been calculated that the Hwang-ho brings down enough material yearly to build a pyramid one mile square and a little less than half a mile high.

PILGRIMS BATHING IN THE SACRED WATERS OF THE GANGES

INDIA'S GREAT WATERWAYS

The four most important rivers of India have their sources at nearly the same point, flow in opposite directions, and after making enormous circuits unite in pairs — the Indus and Sutlej to the east, the Ganges and Brahmaputra to the west. They represent to the natives of India four legendary animals — an elephant, a stag, a cow, and a tiger — which sprang down from the same mountain peak into the green plains of Hindustan.

But the noted river of India is the Ganges. Like the Nile, it is a sacred stream, and the whole Hindu mythology centers round it. On account of its size and its close connection with the life of the people, it is certainly one of the most interesting rivers on the globe. Its sources are in the Himalayas, its mouths in the Bay of Bengal, 1,500 miles away. Starting at an elevation of 13,800 feet, it became entangled in the hair of Siva on its descent from heaven to earth. At least, that is what the sacred story says. What it actually does, is to issue from under an immense bed of snow piled up between three peaks from a height

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THE WHIRLPOOL RAPIDS, BELOW NIAGARA FALLS

The Rapids whose perils have been braved by many who did not live to tell the story, and by one or two who escaped death.

of 13,800 to 22,000 feet. It rushes forth in wild torrents, joins another river, and after traveling down grade more than 12,000 feet in a course of 160 miles, enters the vast plain of Hindustan. From this point it bears on its broad bosom ships and craft of every description, and is the splendid highway through one of the most fertile and thickly settled portions of the earth. The large cities of Calcutta and Benares are on its banks. In front of the steps of the quays at Benares, even in the dry season, the river is almost fifty feet deep. It has many shallows, however, and cuts new channels continually. One season it forms shoals, and the next season sweeps them away, altering its banks from year to year. Its delta begins about two hundred miles from the sea, and forms a wilderness of creeks and rivers, some of which are salt, while all of them are affected by the tides. According to the poet, the delta was formed by Siva squeezing the water from his hair and letting it run out between his fingers; but the less poetical fact is that the delta of the Ganges, like all deltas, was formed by the mud which the river carries along with it, and which is so immense in amount that its annual average is said to be over 534,000,000 tons. From May to November this extensive tract of low, flat land is one vast sheet of water, on which large vessels and small boats, steamships and rafts, swarm and float rapidly along. When the waters lower in November it is found that acres of land have been carried away and other acres formed. Sometimes large islands are made in this way and attach themselves to the mainland, while the river cuts a new channel, perhaps miles away. Thus, thirty-five years ago the city of Rajmahal stood on the river bank; now it is seven miles off. Land-owning is uncertain on this delta.

The Ganges is worshiped by the natives as the goddess "Ganga." A Hindu will often seek the road to eternity by throwing himself into the river. One of the religious customs is interesting. A group of young girls come solemnly down to the river's brink, bringing flowers in a banana leaf. They place this frail boat carefully upon the water, and watch it as it floats off with the current, laden with their hopes and fears. If it upsets, they weep with grief; but if the little flower-boat sails out of sight, they are happy at the good omen, and depart with joy. At daybreak and nightfall the shores are the scene of great activity. Men, women, and children, and even animals plunge eagerly into the water; for by this bath in the sacred river they believe they will be purified and made holy.

THE AMAZON

We usually think of the basin for which a river is the natural water outlet as a fairly small region, perhaps fifty or one hundred miles square. But picture a river whose basin is two fifths of a continent! Such a river is the mighty Amazon in South America, which drains two fifths of the whole continent, and is thirty-five hundred miles long. Its sources are two smaller rivers, which rise high in the Peruvian Andes, and it flows almost across the continent, emptying into the Atlantic through a mouth two hundred miles wide. The Amazon carries to the sea a volume of water vastly greater than that carried by any other river.

THE MISSISSIPPI, FATHER OF WATERS

We need not go outside our own country for great rivers. Much of the life as well as the beauty of the United States depends on its waterways.

The Mississippi, named by the Indians "Father of Waters," is the greatest river of North America. Rising from a little lake in northern Minnesota, it flows southward for twenty-five hundred miles and enters the Gulf of Mexico, having drained in its journey about two fifths of the United States. About midway of its course on the west it receives the giant Missouri ("Muddy Water"), its greatest tributary, which has traveled from far-distant sources in Montana and Canada, making the Mississippi the longest water course on the globe.

The upper Mississippi flows for the most part through a narrow, picturesque valley, which broadens out to the southward into a low, fertile plain.

It is easy to understand the importance of this great river in the history and development of our country. Not only do its rich lands produce the most bountiful of crops, but it has

been from the earliest times a great highway of trade and travel, from north to south, through the heart of the United States. It is interesting, too, to notice that it forms parts of the boundaries of ten states.

A RIVER OF ROMANCE

The Mississippi is indeed a river of romance and adventure. In 1542 De Soto, the Spanish explorer, reached it after a long and fearful march through the southern wilderness — only to die and be buried deep in its mighty bosom by his sorrowing followers.

In the seventeenth century Frenchmen from Canada, including famous missionaries like Père Marquette, were braving untold dangers and hardships in the effort to discover and explore the mysterious "great river" of which the Indians had told them. Louis Joliet and Père Marquette were the first to reach it; while La Salle, a few years later, explored the lower Mississippi all the way to the gulf. In a later attempt La Salle and his party became lost in the wilderness, and the leader was treacherously killed by his own men. These expeditions gained for France the whole great valley, which she held until 1763, when it was surrendered to the victorious English.

The city of New Orleans, situated one hundred miles from the mouth of the river, was founded by the French in 1718. Here was fought the last great battle of the War of 1812. Other great cities on the river are St. Louis, Minneapolis, and St. Paul.

During the Civil War the lower Mississippi was a battleground for the Union and Confederate forces. General Grant won here some of his most brilliant victories, ending in the siege and capture of Vicksburg. Admiral Farragut, too, won a thrilling naval victory when he sailed down the river with his fleet of gunboats, captured the forts at its mouth, and entered New Orleans in triumph.

The Mississippi is fed by two hundred and forty good-sized rivers. Toward the south, as we have seen, it flows through a wide, flat plain, which is lower than the river at full tide. Taking also into account its enormous length, it is not surprising that floods are frequent.

RAPIDS OF THE LOWER MISSISSIPPI NEAR NEW ORLEANS IN THE SPRING FLOODS OF 1910

One of our national problems for many years has been the control of these overflowing waters, which are liable from April to July to do terrible damage. Levees or protective banks have been built along the shores, and dams and systems of canals have been constructed. Since these have failed to prevent the floods, new plans are being worked out. Great engineers declare that we have been working along the wrong lines, in trying to confine the swollen river by high jetties and levees; that Nature has really provided the great valley of the Mississippi with the best of gifts, when human nature learns how to use it. Like the Nile, this great watercourse can fertilize the farm lands on both banks if the spring floods can be directed into channels made for that purpose. These engineers believe that the time is not far distant when, instead of wasting these waters, rich in sediment, where they do damage to health and property, we shall distribute them over the whole Mississippi valley, until the river becomes one of the great irrigators as well as channels of communication of North America.

GREAT RIVERS OF THIS SYSTEM

Several branches of the Mississippi are themselves great rivers with large feeders of their own. The Missouri has two great tributaries, the Platte, nine hundred miles long, and the Yellowstone, eleven hundred miles long. The Ohio, with its chief tributary, the Cumberland, carries even more water than the Missouri, and is the outlet for a flood plain which affords excellent farming land. The Red River, which is longer than the Yellowstone, and the Arkansas, more than two thousand miles in length, add their volume of water to the Mississippi and help to make it one of the greatest rivers in the world.

THE LORDLY HUDSON

No American river is better known than the Hudson. Rising in the Adirondack Mountains, it flows through New York State from north to south, emptying into the Atlantic in the harbor of New York. Near its mouth on the New Jersey shore are the beautiful Palisades, made by sheets of lava which were pushed up through the rock surface of the ground by volcanic action.

The Hudson is peculiarly rich in scenery. The Catskill Mountains rise to the west, and the foothills reach to the river bank for many miles; while at West Point the mountains crowd the river into a narrow pass with a sharp turn. The United States Military Academy has a romantic and rarely beautiful location. A day-boat trip from Albany to New York is one of the trips not soon forgotten.

THE HUDSON'S INTERESTING HISTORY

The river was discovered in 1609 by Henry Hudson, an English navigator in the service of the Dutch, who was trying to find a passage to India by way of North America. This gave the Dutch their claim to the beautiful valley, which was called New Netherlands, until turned over to the English in 1664.

At first wealthy Dutch settlers called "patroons" established great landed estates along the banks of the river, and hired their poorer countrymen to work for them — poor people whose lot was little better than that of slaves. Gradually, however, these great estates were broken up.

The Hudson witnessed some exciting events during the Revolutionary War; such, for instance, as the heroic storming of Stony Point by "Mad Anthony" Wayne. West Point, too, is memorable from the treason of the once brave commander, Benedict Arnold, who planned to surrender it to the enemy, and by the sad fate of Major André, who was hanged as a British spy.

Perhaps no one ever loved the Hudson more than the distinguished American author, Washington Irving, who has so vividly described its beauty and the quaint old customs of its Dutch settlers. The scene of his famous story, "Rip Van Winkle," is laid in the Catskills. Irving died at Sunnyside, his favorite home, near Tarrytown, on the banks of the Hudson — a place which he has immortalized under the name of "Sleepy Hollow."

The first successful steamboat journey in America was made on the Hudson in 1807 by the *Clermont*, built by Robert Fulton, which steamed from New York to Albany — con-

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THE HUDSON AT WEST POINT

sidered a most wonderful trip. To-day some of the fastest and most magnificent steamboats in the world ply up and down the Hudson.

Another great day in its history was when the completion of the Erie Canal, begun in 1817, connected it with the Great Lakes and made it a continuous waterway to the Atlantic Ocean. Enlarged again and again, this canal is now to be the route of a new "barge canal," between Albany and Buffalo, in order that large ships may continue directly on their way from the Hudson to the Great Lakes.

THE HUDSON A "DROWNED" RIVER

A most interesting fact regarding the Hudson is that it is a "drowned" river. Scientists tell us that ages ago the valley through which it flowed extended out into what is now the Atlantic Ocean, seventy or eighty miles eastward of Long Island, but that the lowering of the land caused the ocean waters to rush in and "drown" it. The tides can now be felt as far north as the city of Troy, a hundred and sixty miles from the mouth of the river; and the water is sometimes salt as far up as Poughkeepsie, seventy-five miles from New York.

THE ST. LAWRENCE

The St. Lawrence, forming part of the boundary line between Canada and the United States, is another great and important American waterway. Rising in the highlands of Minnesota, it flows onward through the chain of the five Great Lakes, and finally empties into the Gulf of St. Lawrence, forming altogether the greatest system of inland navigation in the world.

MONTREAL AND THE ST. LAWRENCE, FROM MT. ROYAL

It is interesting to know that these same Great Lakes were themselves rivers uncounted ages ago, until mighty glaciers from the north bore down upon them, clogging up their courses, and turning them into what we now find them — great basins of fresh water.

After emerging from Lake Ontario, the river is broken by numerous cataracts or rapids. "Shooting the rapids" has always been a thrilling and sometimes dangerous incident of navigation on the St. Lawrence; but the cata-

racts can now be avoided by the use of the great canals which connect Lake Ontario with Montreal.

FAMOUS SPOTS ON THE ST. LAWRENCE

Everyone has heard of the "Thousand Islands," which are actually about fifteen hundred charming and picturesque islands in the St. Lawrence, lying between New York State and the province of Ontario. They are favorite summer resorts and are dotted with beautiful summer homes.

Passing down the river, we come to the great city of Montreal, head of ocean navigation on the St. Lawrence. During the season of open navigation, from April to December, its splendid harbor is crowded with ships from foreign ports. Farther on we reach Quebec, situated on a steep bluff and commanding one of the finest views in the world. The citadel of Quebec is the strongest fortress on the American continent. In 1759 it was taken from the French by the English under General Wolfe, in a great battle on the Plains of Abraham above the city.

OTHER INTERESTING FEATURES — PORTAGES

At Quebec the river widens into an estuary or arm of the sea, extending four hundred miles to the Gulf. The original valley of the St. Lawrence reached far out into the ocean, this being an even more remarkable example of a "drowned" river than the Hudson.

The watercourses of those two great rivers, the St. Lawrence and the Mississippi, approach so near each other in places that in the old days Indians would pass overland in their journeyings from one river system to the other, carrying their canoes on their shoulders. The trails they made were called "portages," and were much used by the white settlers and Jesuit missionaries, enabling them to travel immense distances in their canoes. Thus we see the great geographical importance of the two rivers, both separately and in connection with each other, and realize how deeply they have influenced the history and prosperity of our country. Lovers of history will not forget that Champlain founded Quebec in 1608, and discovered Lake Champlain.

QUEBEC AND THE PLAINS OF ABRAHAM

THE COLUMBIA

The great river of the Northwest is the Columbia. From its fountainhead in the Rocky Mountains it flows westward into the Pacific, forming part of the boundary between Washington and Oregon. Its main tributary, the Snake River, has also carved out for hundreds of miles a wonderful cañon. A strange and oppressive gloom clings to this cañon because of the black basaltic rocks of which the cliffs are formed. The upper parts of this system are unnavigable because of the many falls and rapids, but offer for that reason magnificent scenery. The Shoshone Falls are among the most famous in the United States. So many salmon pass up the Columbia to lay their eggs that the catching and canning of these fish has become a leading industry.

The mouth of the Columbia was discovered in 1792 by Captain Gray of Boston, who named the river after his ship. During the administration of President Jefferson, Captains Lewis and Clark, in a wonderful expedition, reached the headwaters of the Missouri, and crossing over to the Columbia, explored that river to the Pacific. This exploit made known to the people of the United States for the first time the great region of the Northwest.

CIGAR ROCK, COLUMBIA RIVER

THE BOLD CLIFFS ALONG THE COLUMBIA

THE GRAND CAÑON OF THE COLORADO

One of the most remarkable of rivers is the Colorado, which rises in the mountains of Colorado, Wyoming, and Utah, and flowing for the most part through a high and arid table-land, enters the Pacific through the Gulf of California. Throughout a large part of its course it has cut in the solid rock of the table-land a magnificent cañon which is one of the wonders of the world.

The Grand Cañon of the Colorado is a stupendous gorge some fifteen or more

miles across, hundreds of miles in extent, and with a depth of about a mile. Its steep, towering cliffs are sculptured into wonderful shapes and colored to the most beautiful and varied of tints. Enormous ridges extend for miles out from the brink of the chasm, and towers and pinnacles are everywhere. From the depths of the cañon rise wondrous temple-like forms of gorgeous coloring, towering as far above the flowing river as the summit of Mount Washington rises above the sea. The river's work is not done. It is still wearing away rock, and will probably in the next hundred years carve many more designs on the massive rocks that rise along its course in sheer, impassable precipices. The Grand Cañon has been little explored because of the hardships and constant danger accompanying such attempts.

THE POTOMAC

A river of beautiful scenery and historic interest is the Potomac, which divides the States of Maryland and Virginia and flows into Chesapeake Bay. On its banks is situated the capital of our country, as well as such historic places as Arlington and Mount Vernon. During the Civil War armies crossed and recrossed its upper fords, and battles raged fiercely on its banks. One of the great divisions of the Union forces was called the "Army of the Potomac."

OTHER AMERICAN RIVERS

Two eastern rivers of note are the Connecticut, the longest in New England, and the winding Merrimac, which with its many factory cities is said to turn more spindles than any other river in the world. The Cumberland, which rises in Kentucky and flows into the Ohio, is important as the outlet for a great logging country.

The Allegheny and Monongahela rivers, flowing down from the mountains in western Pennsylvania, unite at the point where Pittsburgh is located, and form the Ohio. Duquesne Heights and Mt. Washington, which make this point picturesque, are notable historically because it was here that the English General Braddock, in July, 1755, was ambushed by the French and Indians and mortally wounded, while his troops were utterly routed. The reason we remember this is because George Washington was a colonel in Braddock's command, and was one of the few officers who escaped, out of the eighty-six engaged in the battle. Who can tell how much that escape meant to our country?

The Conemaugh is another Pennsylvania

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PITTSBURGH, OPPOSITE MT. WASHINGTON

river, and it was on this stream, at Johnstown, that one of the most terrible disasters in our history occurred in 1889, more than two thousand persons losing their lives, and the greater part of the thriving mountain town being swept away.

Another river with which the name of Washington is associated is the Delaware, which rises in the Catskill Mountains, and forms part of the boundary between New York and Pennsylvania and the boundary line of New Jersey on the west. Trenton, the capital of New Jersey, is at the head of navigation on the river, and at Philadelphia the Schuylkill joins it. Widening below Philadelphia, the river expands into Delaware Bay. Some of our largest shipbuilding plants are on its banks, between Philadelphia and Wilmington, and to this waterway Philadelphia owes its growth into one of our largest cities. The picture of Washington crossing the Delaware at night in winter, when the cakes of ice made the passage doubly dangerous, is a schoolboy favorite. The Delaware Water Gap, where the river pours its waters through a narrow gorge for about two miles, with the

cliffs rising more than a thousand feet in height, is a noted resort and one of the most beautiful scenes we have to show foreign tourists.

The Susquehanna is another exceedingly picturesque river, issuing from lakes in New York, flowing through the Appalachian valleys in New York and Pennsylvania, and finding outlet in the Chesapeake Bay in Maryland. The river is 422 miles in length, and has on its banks such cities as Binghamton, Wilkes-Barre, Harrisburg, the capital of Pennsylvania, and Port Deposit in Maryland, above which the river is not navigable.

The Niagara River is only twenty-eight miles in length, connecting Lakes Erie and Ontario, but Niagara Falls makes it a stream that everybody wants to see. That cataract, a chief among the world's wonders, is described elsewhere.

A large river of the southwest is the Rio Grande, which rises in Colorado and flows into the Gulf of Mexico. Below El Paso, Texas, it becomes the boundary line between the United States and Mexico. Flowing through an arid country, its waters are used all along its course for irrigation.

The Sacramento, a large river of California, rises near Mount Shasta and drains into San Francisco Bay, after passing through the Great Central Valley. It keeps its valley very fertile and is also useful for hydraulic mining. Sacramento, the state capital, is situated on its bank.

Of course we cannot even name all the rivers of an immense country like ours. Each state has its rivers, essential both for irrigation and navigation. Sometimes we first become familiar with a river not located in our particular section, because of some disaster. Thus, the great floods in Ohio, at Columbus and Dayton and other points, brought into prominence smaller rivers like the Big and Little Miami, and the Muskingum, which ordinarily flow on in peaceful obscurity. Indiana has its Wabash, and Illinois its river of the same name, 350 miles in length, which made it possible to drive the water of the Chicago River into the Mississippi instead of Lake Michigan. The more you learn of the rivers, the more you will understand what a fortunate land ours is in the water distribution. And wherever you find a river, there you will find also prosperous towns and cities and rich farming communities.

A DANGEROUS DIVERSION — SHOOTING THE RAPIDS

RIVERS AND OCEANS

A study of the map with regard to the distribution of rivers over the surface of the earth shows that many more watercourses flow into the Atlantic than into the Pacific. The latter ocean, the greatest of all, receives directly only five considerable rivers — the Cambodin, the Yangtze, the Hwang-ho, the Amoor, and the Columbia. The Atlantic, on the other hand, is the reservoir into which the most enormous rivers pour their waters — the Amazon, the Orinoco, the Mississippi, the Nile by way of the Mediterranean, the St. Lawrence, the Congo, the Niger, and all the watercourses of western Europe, as well as many others.

MOUNTAINS THE MOTHERS OF RIVERS

In general the great watercourses have their source in lofty and massive heights. Our Mississippi gathers in her capacious arms springs and runlets, cascading brooks and quiet streams, from the eastern flanks of the Rocky Mountains to the Blue Ridge, beckoning them along devious yet ever converging paths down to her delta. In Europe the snowfields and glaciers of the clustered Alps form a reservoir whence rivers radiate in all directions — the Rhine to the Atlantic, the Oder and Warthe to the Baltic, the Danube, Save, and Drave to the Black Sea, the Rhone and the Po to the Mediterranean. But the combined amount of water flowing away from the Alps, the Pyrenees, and the Carpathians is small compared with the supplies yielded by that huge elevation in Central Asia, well called "the roof of the world," whence a round dozen of rivers, each more than a thousand miles long, besides innumerable smaller ones, course away towards the sea, carrying the melted snows of the Pamir, the Himalayas, and the mighty ranges that surround the plateau of Thibet and Mongolia, to the warm bosom of the Pacific and Indian oceans, or to the icy embrace of the Arctic Sea.

GREAT DIVIDES

An elevation which separates one watercourse from another, or sends the rainfall on one side into one river system and on the other slope into another system, we call a "divide." Each continent has one or more "great" or "continental" divides, which separate all the waters flowing into one ocean from those draining away to another. There are three in North America: the Rocky Mountains, west of which all the waters go to the Pacific, and east of which all the drainage is into the Gulf of Mexico; the low "height of land," which runs irregularly from southern British Columbia to the

THE GREAT DIVIDE BETWEEN THE ATLANTIC AND PACIFIC WATERS IN THE ROCKY MOUNTAINS

vicinity of Lake Superior and thence east to Labrador, dividing the rivers flowing to the Arctic Ocean and Hudson Bay from the tributaries of the Missouri and the St. Lawrence; and the Blue Ridge and its extension northeastward, the Gaspé, which separate the Ohio and St. Lawrence valleys from the Atlantic slope. Along the crests of these three divides originate all the rivers of importance; and a similar classification of systems may easily be made for the Old World by a study of the map of the Eastern Hemisphere.

GREAT CITIES AND GREAT RIVERS

It is an old query: "Why do big rivers always flow by big cities?"

Anyone may see through and laugh at the topsy-turvy logic; and anyone by a moment's thought may understand how it is that, as a matter of fact, important cities have nearly always grown on the banks of large rivers or at their mouths. It would be hard to find an exception to this, apart from towns like Denver,

Winnipeg, Calgary, Manchester, Johannesburg, and some Russian cities, which have sprung into life since railroads furnished sufficient transportation for the needs of interior districts. The great towns of ancient days — Nineveh, Babylon, the Chinese, Japanese, and East Indian cities, Tyre, Sidon, Byzantium (Constantinople), Rome, and Carthage — were each on a navigable river or beside the sea — usually both. It was so in medieval Europe, and the principal reason for it was the same as in the ancient East, namely, that almost all ancient travel and trade was by water.

When you have a load to carry across country you seek a level path and avoid hills, you take advantage of every slope and valley that lead in your direction, and where a river is handy you construct some sort of boat and utilize that. Thus, in a primitive time or region, wherever a river with its branches offers navigable waters, travelers and traders, producers and merchants will naturally gather in its valleys. Much commerce has always been sea-borne, and the sailors and merchants engaged in it have always found it most profitable to carry their goods as far by water as possible, for transshipment is expensive and slow; hence they seek the innermost parts of bays and harbors, and ascend rivers as far as they can, before landing their cargoes. Thus the inlanders coming down the river valleys, and the sea traders sailing up them, meet most conveniently, and therefore most numerously, at the head of navigation, which, in old days, remember, was higher upstream in many cases than now, because the ships in use then were much smaller.

So it has naturally come about that population everywhere is most dense along the watercourses (the superior fertility of valleys must also be considered), and that the great cities have grown almost invariably where river and sea navigation meet. Think of the many examples — London, Paris, New York, Philadelphia, Amsterdam, Buenos Ayres, Montreal, Hankow-Wuchang, Calcutta, and many others — which fit that situation and history. Even the modernization of methods of transportation has made no serious change, for heavy freight is still carried most economically by water, and all railroads seek the lowest and easiest routes to the ports — water grades, as engineers call them.

What but its situation has enabled New York to become the second largest city in the world? From New England by the East River, from northern New York and Canada by the Hudson, from the West by the Erie Canal along the Mohawk and then down the Hudson, from the Southwest by the Delaware, Raritan, and Passaic valleys, all the easy roads by either land or water lead to the American metropolis and its incomparable harbor. Hence it *is* the metropolis!

Similar conditions have built up Philadelphia, Boston, Baltimore, Pittsburgh, St. Louis, New Orleans, San Francisco, and the towns on the shores of the Great Lakes.

SOME RIVER FIGURES

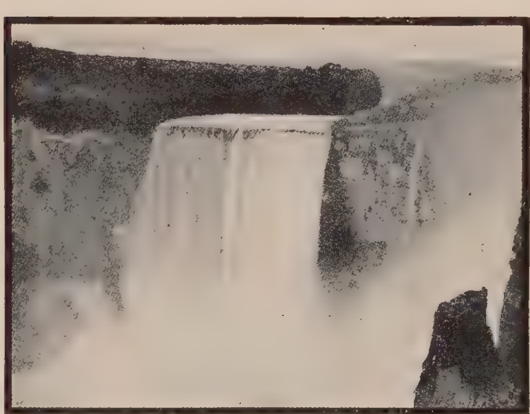
River	Length in Miles	Drainage Area in Square Miles	Annual Rainfall in Cubic Meters
Rhine	810	86,500	19.500
Oder	550	43,500	14.700
Niemen	565	36,450	10.355
Vistula	650	74,000	19.908
St. Lawrence	2,000	482,000	388.967
Danube	1,800	315,000	198.736
Po	420	27,000	23.887
Volga	2,300	500,000	152.384
Seine	480	30,000	10.266
Rhone	505	38,000	22.439
Dnieper	1,330	202,000	56.093
Loire	545	47,100	18.210
Dniester	855	76,500	8.792
Yangtze	3,500	685,000	408.872
Hwang-ho	2,300	378,500	117.711
Nile	4,370	1,082,000	892.120
Mississippi	4,200	1,254,000	673.064
Rio Grande	1,800	220,000	113.655
Indus	2,000	370,500	104.416
Ganges	1,500	409,500	548.791
Magdalena	1,060	102,500	116.746
Irawadi	?	166,000	180.849
Krishna	800	104,500	61.025
Godavari	900	119,500	95.924
Orinoco	1,500	365,000	603.397
Amazon	4,000	2,722,000	2,833.830
São Francisco	1,800	252,000	218.459
Congo	2,800	1,425,000	1,213.044
Orange	1,300	370,000	50.913
La Plata } Uruguay }	2,400	1,200,000	{ 904.687 { 130.890

THE WATERWAYS OF THE WORLD

These relief maps of continents enable one to trace the great river courses of the world. This comprehensive glance shows the remarkably even distribution of water, and its absence in the desert belt. (Three lower maps used by permission of Ginn & Co. Copyright, 1912, by A. E. Frye.)

WATERFALLS AND RAPIDS

As a river works its way from the mountains to the sea, it passes over many kinds of rock and soil. Even in a single spot there will be layers of soft and hard rock, laid one upon another like planks in a lumber pile. As the water flows over these rocks, it will wear down the soft more swiftly than the hard and will even carry off some of the layers, leaving the others rising from the river bed in sharp cliffs. The river bottom at the foot of such a cliff will be quickly worn away by the force of water falling from the height, and the head of a waterfall will be formed. When the water drops straight down, we call it a waterfall or cataract; when it tumbles over rocks which are not high enough to make a long drop and yet break its even course, we say it makes rapids. Some of the world's waterfalls have been worn away within the time that man has lived on the earth; but the more magnificent ones were probably caused, not by running water, but by moving ice, which in the glacial age covered the world. As this ice moved along, it cut into the land; then running water did the rest.



KAIETEUR FALLS, THE HIGHEST KNOWN

NIAGARA

Niagara Falls is our most wonderful waterfall, and is commonly said to be the grandest in the world. It is only 160 feet high, while the Victoria Falls of the Zambesi River in Africa are given as 420 feet high. and the Kaieteur Falls of British Guiana are 822 feet high; but the amount of water coming over the cliffs of Niagara is so great that it is thought to surpass the higher falls in grandeur. Long before the white man saw these falls the Indians looked on them with awe and dread, and gave them the beautiful Iroquois name, Niagara, the "Thunder of Waters."

The first white man known to have seen Niagara was the famous explorer, Father Hennepin, who was a member of La Salle's party in 1678. He wrote in the quaint language of the time that "the Waters which fall from this horrible precipice do foam and boyl after the most hideous manner imaginable, making an outrageous Noise, more terrible than that of Thunder."

More than a hundred years later another famous Frenchman gazed upon Niagara, and left a description that is well worth repeating. Said Chateaubriand, the brilliant friend of the heroes of our Revolution:

"From Lake Erie to the falls the river bed descends very rapidly, and at the point where the waters take their leap, it is less a river than an ocean whose floods hurry into the yawning gulf below. The cataract is divided into two portions, and is curved in the form of a horseshoe. An island juts out between the two falls, which is hollowed out underneath, and hangs suspended with all its trees over the chaos of waters. The mass of water which falls in the center rounds out like a great cylinder, and then unrolls in a snowy sheet, which glistens with every color in the sunshine. That on the east side falls into frightful shades, a very deluge of water. A thousand rainbows curve and cross each other over the abyss. The water striking the yielding rock rebounds in whirlwinds of vapor, which rise above the forest like the smoke of a vast conflagration. Tall pines and hickories and phantom-like rocks decorate the scene. Eagles are carried whirling down to the bottom of the gulf, dragged down by the current of air, and lynxes suspend themselves by their long tails to the end of some branch over the abyss in order to seize the mangled remains of the elk and the bear brought down by the waters."

This is a very vivid picture, and while the forest has given way to houses and streets,

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CREST OF NIAGARA FALLS AS SEEN FROM PROSPECT POINT

This gives some idea of the vast flow of water that pours over the American Falls.

NIAGARA IS MARVELOUSLY BEAUTIFUL IN WINTER DRESS OF ICE

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GOAT ISLAND, BETWEEN THE CANADIAN AND AMERICAN FALLS

In this small protected space a visitor can stand perfectly secure in the midst of the swirl of overpowering volumes of thundering water.

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LOOKING INTO THE CAVE OF THE WINDS, UNDER THE FALLS OF NIAGARA

The trip under the falls is perhaps the most exciting experience at Niagara. There is enough danger to give spice, and the sense of awe is inevitable.

and eagles and lynxes no longer indulge in such amazing acts, the description of the rushing waters divided by Goat Island remains accurate and striking. Goat Island lies between the American and the Horseshoe Falls, and it seems as though every instant this torrent-swept land would be carried bodily down into the abyss. It resists the tremendous force, however, though every little while a big bowlder is torn away and hurled into the seething depths. On one point of Goat Island is the celebrated Cave of the Winds, a grotto near the foot of the cataract. Here the courageous visitor, wrapped in a veritable whirlwind, may be said to be in the very heart of the falls. In that rocky chamber there is nothing between him and the huge curtain of water, from six to ten yards thick, falling in a deafening roar.

It is of interest to know that Lyell, the great geologist, estimated that Niagara Falls had worn its way backward three and a half miles in about 35,000 years. Between 1842 and 1905 the falls had receded about four feet per annum. In far-away dim centuries to come, the cataract may creep right up to Lake Erie, unless the harnessing of it robs it of all power. By "harnessing" we mean using the force of the water for manufacturing purposes, electric light, and transportation. Niagara is thought to be able to generate several millions of horse-power. At the present time about 600,000 horse-power is utilized.

FAMOUS WATERFALLS

The highest succession of falls in the world are those of the Yosemite Valley in California. Two ledges of rock break the flow of water into three falls, the total height of which is over 2,000 feet. At the beautiful Staubbach Fall in Switzerland, a narrow ribbon of water makes a sheer drop of nearly 1,000 feet and is thrown back in white mist before it reaches the ground, so that the bottom of the fall is always lost in cloud.

There are remarkable cataracts in many places in the world — among them the Schaffhausen Falls on the river Rhine; the Riukan-fos, in Norway, which leaps 885 feet; the Paulo Affonso, in Brazil, which divides into four immense columns and dashes down a gulf 246 feet deep; and the beautiful Bridal Veil Fall, in the Yosemite Valley, which has a sheer drop of 630 feet, and looks like a fluttering silver scarf with rainbows interwoven.

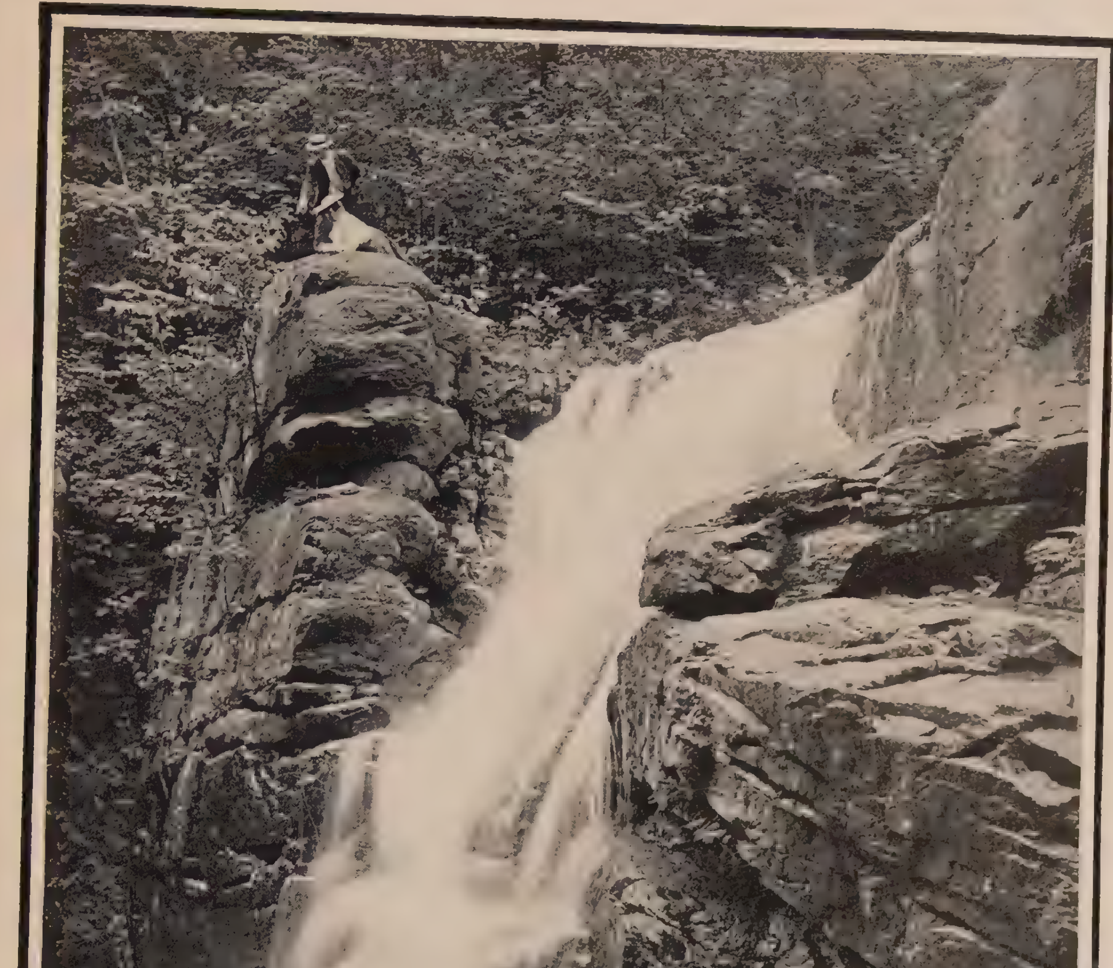
The Victoria Falls in South Africa are much larger than Niagara, being 1,860 feet wide to Niagara's 1000 feet, and nearly three times as high. They were discovered by David Livingstone in November, 1855, and named by him for Victoria, then queen of England. Sometime you will read the story of his explorations in Africa, and get a little feeling of what it would mean to come upon such a wonderful sight as these falls, and know that you were the very first white man who had ever seen it. Think of taking back to the world the story of such a nature wonder as this, of which no one had ever heard before!

WATERFALLS IN THE UNITED STATES

While the grandeur of Niagara is not elsewhere equaled in the United States, there are, nevertheless, many very beautiful falls that afford evidence of Nature's generosity. Just east of the Rockies the Missouri River forms quite a series of rapids and falls, among which the best known are doubtless those at the point where the city of Great Falls is located.

Idaho is particularly fortunate in the scenic beauty of the falls made by the Snake River, where it crosses the southern portion of the state. Here it cuts deeply into the crust of lava spread over that region, and so varies its course by rapids and waterfalls. Famous among these are Twin Falls and Shoshone Falls. Just below the latter a short cañon of the Snake River opens into the greater cañon and heads in a natural amphitheater 300 feet in depth. This chasm receives no water from the surrounding plains, but is fed abundantly by subterranean streams that find outlet in great springs in the bottom of the valley.

Another western state that claims a beautiful waterfall is Oregon. For the Columbia River, just below the Cascade, drops hundreds of feet over a sharp precipice and seems to form a shining ribbon of water as it falls. Multnomah Falls, which is the loveliest, is said to be about 800 feet in height.



Courtesy of E. S. Jones

FALLS IN THE WHITE MOUNTAINS, NEW HAMPSHIRE

Courtesy of Travel

AMONG THE DOLOMITES

GLACIERS, RIVERS OF ICE

GLACIERS have already been described as rivers of ice moving down gorges from high mountains, whose peaks are perpetually covered with deep blankets of dazzling snow. The changing of snow into bluish, transparent ice is one of Nature's magical processes. First the falling flakes pile up in high snow banks on the mountain tops during the winter; then at the touch of spring sunshine they begin to melt and cling together, and the closer they cling the firmer and more solid are the snow masses. Any child making a snowball knows how this is done. Press the snow together and it will become solid and hard. On a mountain slope the pressure of hundreds of tons of snow forms ice which is almost as hard as rock. The increased weight tells the fact in striking figures: A cubic yard of snow weighs on the average one hundred and eighty-seven pounds, while a cubic yard of glacier ice weighs over ten times as much. It is easy to see that, with such weight, if the mass once begins to move, nothing can resist it.

Slowly, very slowly, the ice moves downward and gets entangled in mountain gorges or fills up whole valleys. Some of these glaciers — those of the Pyrenees, for instance — extend only over the upper slopes of the mountain, and do not descend through the gorges as far as the cultivated land at its base. These are known as secondary or summit glaciers. Other fields of ice flow out into the mountain amphitheaters and make their way into the lower valleys, and these are glaciers of the first order.

On its course the solid river behaves as would a real river of running water. It has its meanderings, its eddies, its depths and shallows, its rapids and its cascades. Like the water, which expands or contracts according to the form of its bed, the ice adapts itself to the dimensions of the ravine containing it. It knows exactly how to mold itself upon the rock, as well in the vast basin whose walls widen out on either side as in the defile where the passage almost closes up. But the ice, lacking the fluidity of water, has to accomplish all the movements forced upon it by the nature of the ground in an awkward though picturesque manner. It cannot, at its cataracts, fall in one level sheet as does the water current; but, according to the irregularities of the bottom and the condition of its ice crystals, it cracks, splits, gets cut up into blocks which lean in every direction only to fall over one another like clumsy clowns, and become cemented together again in funny obelisks, towers, and fantastic groups.

HOW FAST DO ICE RIVERS MOVE?

Alpine mountaineers knew for ages that glaciers moved onward, conveying masses of rock from the mountain tops to the valleys, but the fact was not known to scientific men until the end of the sixteenth century. No one actually tried to prove it until a seeker after knowledge, named Hugi, built a little hut on the glacier

THE MER DE GLACE, SWITZERLAND

LAVA STREAM FLOWING INTO A LAKE, HAWAII

Unteraar, in 1827. Three years later the hut had moved down 330 feet; at the end of six years it had traveled 2,340 feet; and by 1841 it had reached a distance of 4,683 feet from its first position, or the best part of a mile. Professor Tyndall spent much time studying the glaciers of Switzerland, and he observed that their most rapid movement was thirty-seven inches a day. But there were also places where the motion was not more than two inches a day. Up in Alaska there is an immense ice river, the Muir Glacier, flowing at its narrow outlet at the rate of about seventy feet a day, and falling *into the sea.* Really feeding the ocean with icebergs! Dr. G. F. Wright describes it in the following vivid passage:

"There is a constant succession of falls of ice into the water, accompanied by loud reports. Scarcely ten minutes, either night or day, passed without our being startled with such reports; and frequently they were like thunderclaps or the booming of cannon at the bombardment of a besieged city, and this though our camp was two and one-half miles below the ice front. . . . Repeatedly I have seen vast columns of ice extending up to the full height of the front topple over and fall into the water. How far these columns extended below the water could not be told accurately, but I have seen bergs floating away which were certainly five hundred feet in length," or as high as the Washington Monument.

WHY ICE RIVERS MOVE

The cause of the motion of glaciers puzzled wise men for a long time, for they discovered that it was not due to the weight of the ice, nor to its melting. In many instances glaciers were found frozen to the ground, and gravity could not apparently dislodge them. It was Tyndall who solved the mystery. He showed by theory and experiment that the movement was due first to the countless fissures or cracks seeking to close up. Ice has a strong tendency to stick together. Even in warm water two pieces of ice

A BLIZZARD ON THE BERGEN-CHRISTIANIA RAILWAY, NORWAY

The Bergen line was buried beneath huge deposits of snow. Two English mountain climbers were lost, and their bodies were found over four miles apart, after many days of search by a military expedition. Similar blizzards are experienced in the West.

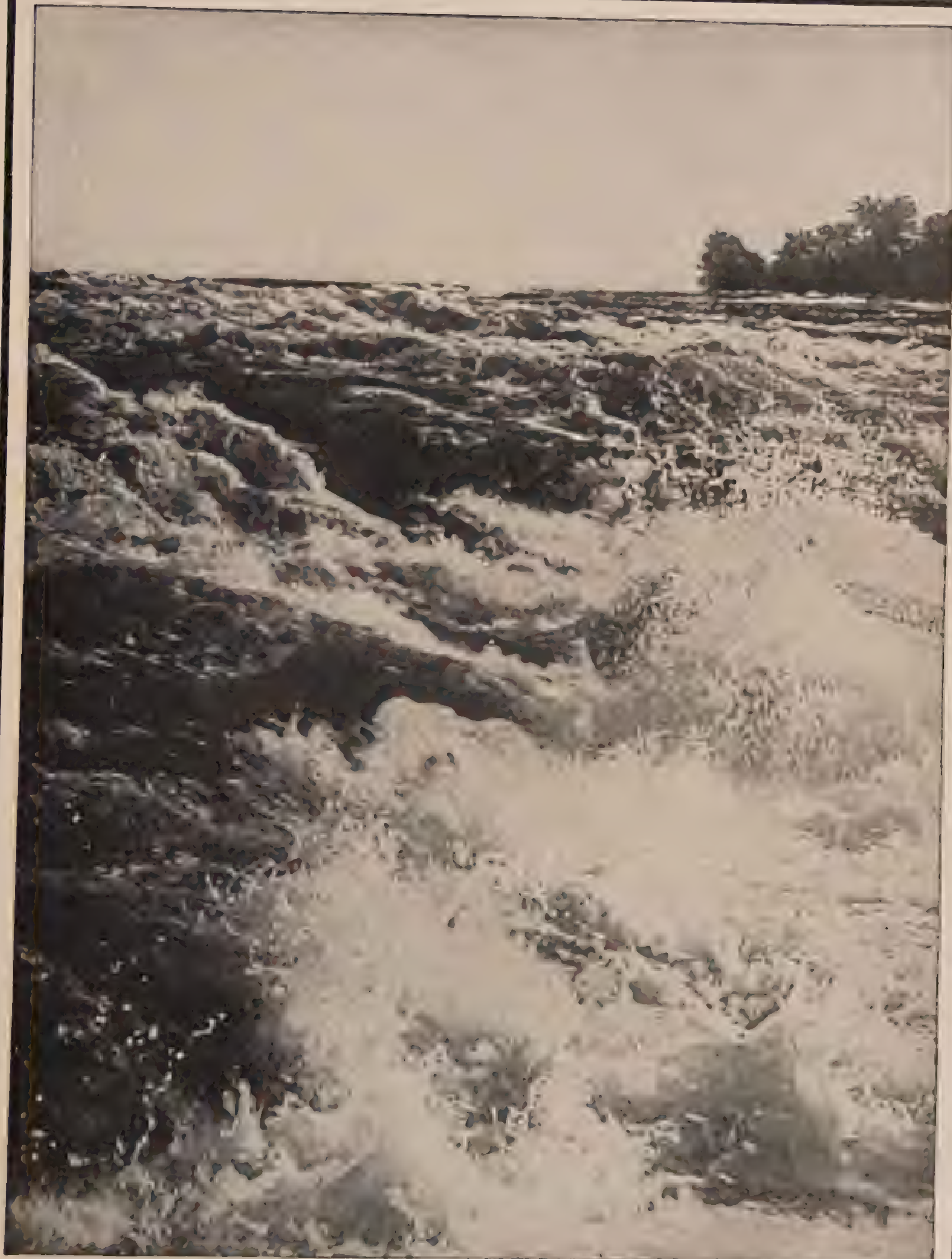
which are melting continually strive to get together. And so it can be easily understood that, when in a glacier millions of cracks are trying to close, it means a never-ceasing motion which carries the river of ice down the slopes to the valleys.

These cracks, or, more properly, crevasses, are by far the most interesting feature of a glacier. Often they reach a tremendous width and depth. Sometimes they are hidden under banks of snow, and it is then dangerous to travel over the ice river. But suppose we are looking down into one of the cold chasms, what do we see? Layer upon layer of bluish ice separated by black bands, which mark the remains of débris fallen upon the once snowy surfaces. At another time and place the crevasse walls will appear perfectly clear. We wonder what is the depth of the chasm, but cannot guess, for a short distance down the darkness becomes impenetrable. We may hear a mysterious noise from the abyss. What is it? The roaring of a buried stream, perhaps, reverberating in the echoing walls of ice, or the crash of a stone falling hundreds of feet. Explorers have been let down by ropes into these chasms to measure their density and to study the temperature and composition of deep ice. These experiments, like all glacier study, are attended with great danger, since the ice may shift at any moment and crush a man between its blocks. Many a mountaineer has met his death crossing these changing ice chasms.

The Alps have the most famous glaciers, like the Mer de Glace and the Rhone and the Great Aletsch glaciers; but there are as wonderful and extensive ice rivers in Scandinavia, in Greenland, and in Alaska. They serve to remind us of the Glacial Age, when the greater part of our North American continent was covered by a huge sheet of ice, which was polishing our mountains and valleys into shape. The Niagara gorge was made by ice action.

Courtesy of National Geographic Magazine

A GIANT CREVASSE, ONE PERIL OF MOUNTAIN CLIMBERS



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NIAGARA FROM PROSPECT POINT — THE RAPIDS ABOVE THE FALLS

No one has ever entered these tumbling waters and come through alive. Once drawn into their swift current, the unwary boatman is rushed straight to the great falls and to destruction in the vast churn below.

HOT SPRINGS AND GEYSERS

IN all the volcanic regions of the world there are places where hot springs bubble up from the ground. All springs are thrown up by underground waters stored from the surface rainfall which has drained down. These have been stored near veins of hot lava or melting rock, which has heated them to temperatures varying from sixty degrees to boiling point. When these springs send columns of water and steam high in the air, they are called geysers. There are geysers in New Zealand, Iceland, and the Yellowstone Park, all volcanic regions. As the water rises, it brings up many mineral substances, so that the deposits around the hot springs are often brilliant in color. Sometimes geysers build cones, like a miniature volcano.

YELLOWSTONE GEYSERS

Yellowstone Park, in Wyoming, is the most wonderful of places in which to see geysers of all kinds and sizes, from tiny jets to living pillars of seething waters. In what is called the Upper Geyser Basin there are hundreds of hot springs in all phases of activity. "Old Faithful" is here, one of the most beautiful geysers imaginable, throwing its snowy stream to a height of from 125 to 150 feet every sixty-five minutes. Not far from it is the "Beehive," called so on account of the shape of its cone, which flings its water-plume as high as 200 feet. Then there is the "Giantess," which every two weeks performs for the sight-seer; the "Grand," whose exhibitions last for some time but are irregular in coming; and the "Giant Geyser," which is thought by many to be the finest in the whole Basin. It is erratic in its performances, but when they do take place there is no more sublime sight than the 250-foot shaft of foaming water leaping from the ground in seeming frenzy.

Elisha Gray, one of our foremost scientists, gave a striking word picture of one of these geysers in action:

"The geyser that produced the greatest excitement and enthusiasm of all was called the 'Grand,' which played once in twenty-six hours. When I saw it in action it was late in the afternoon, and, standing between the sun and the geyser, with my back to the former, I had the advantage of the reflected light, which is very bright in that high altitude. Close by the side of the geyser is a steam blowhole about six inches in diameter, and all about are a number of boiling springs that are connected with the geyser. Just before the play began all these springs were in great agitation in sympathy with the coming event. As a final preliminary, this steam blowhole started up, giving a blast of terrific power.

"The moment the steam trumpet made the announcement, the water in the top basin of the great geyser heaved several times as if unable to make a start, and then lifted itself up bodily for more than one hundred feet into the air. It took the shape of a beautifully formed evergreen tree whose branches cover the trunk down to the ground, the tips of which are loaded with cones set with purest diamonds. These cones shot out from the center on moving stems and burst into brilliancy at the limit of the tree-like form, producing an effect something like that of a rocket when it first bursts in the air, and before it has fully spread. Imagine thousands of these jets moving in all directions and bursting into beautiful colors, now vanishing and now others taking their places, till one is excited to the highest pitch by this wonderful exhibition of color, form, and motion. All the time Nature's great steam foghorn is sounding its thunderous note beside the geyser as if sympathizing with this mighty effort of pent-up energy.

"After keeping up this wonderful display for fifteen minutes it suddenly stopped, all but the steam jet, which seemed as vigorous as ever, and the water rapidly receded down the tube of the geyser till out of sight. In a few seconds the water was seen quietly but rapidly coming to the top, and when it reached there it suddenly burst into full form and height for one short moment and receded as before. It came back and receded seven times, and at each coming it made the same burst, until at the seventh pulsation the steam jet suddenly stopped, as much as to say, 'Gentlemen, the show is over.'"

A famous scientist, Bunsen, from whom our Bunsen burners are named, first found out the cause of geysers. He knew that steam from boiling water had a tremendous power of expanding. He also knew that the boiling point

NOTED GEYSERS IN YELLOWSTONE NATIONAL PARK

Top: Fountain Geyser. Middle: Grotto Geyser. Bottom: Giant Geyser Cone.

TOP ROW: CASTLE GEYSER, YELLOWSTONE; LIBERTY CAP, MAMMOTH HOT SPRINGS
BOTTOM: GOLDEN GATE CAÑON; GORGE OF THE AMMONOOSUC, NEW HAMPSHIRE

of water was increased by pressure. So this was the way he worked it out: In a geyser, a column of heated water is standing in an upright tube, and is being heated at the bottom. At the bottom of a long tube such as forms one of these hot springs the boiling point would be higher than at the surface. At the bottom of the Great Geyser, for instance, the boiling point is 257 degrees, while on the surface with no pressure of water above it water boils at 212. We know how boiling water makes steam in our kettles, so that we must have a spout to carry it off. The steam made at the bottom of the tube pushes on the upper layers and sends them violently into the air. The water is cooled in its eruption one hundred feet into the open air, and must be heated again after it has fallen back, before it will be hot enough to boil and be thrown up again. This explains the regular intervals at which the geyser sends out its eruption. It also indicates the tremendous force that drives the water upward.

AVALANCHE, NEAR A GLACIER, IN THE SWISS ALPS

BREAKS IN NATURE'S ROUTINE

OLD Dame Nature is a lover of habit and routine. She has laid down a set of laws, by which she tries to keep all her forces in order. She must do this for the sake of her living children, for only by the most careful management of the giant forces under her control can she hope to keep life on the earth. She must look after the forces that make heat, for if there was an oversupply of heat the earth would become too dry and parched to support any living creatures. Let cold have its way and freeze all the surface water, and in a very short time all life would disappear from the earth. And as for wind and fire, if they had nothing to check them, how quickly all our cities and homes would be blown away or reduced to cinders.

We human beings are the most adaptable of all Nature's children. Most plants and animals have their special regions where the conditions are exactly right for their life, and they die if they are put down in surroundings which are radically different. But there are very few places on the globe where men have not lived. They go to the arctic regions and to the hottest

desert places, and manage to survive the trying conditions which they meet there. But this is because of the balance of forces which Nature keeps. Let one of these forces get a little out of the usual bounds and break the routine to which we are accustomed, and suffering and death follow, as when we have avalanches, tor-

Courtesy of National Geographic Magazine

ICE SLOPE ON A MOUNTAIN SIDE

nadoes or earthquakes, terrible droughts or floods.

When we talk of these happenings as breaks in Nature's routine, we do not mean that Nature's laws are broken. Each follows some one of these laws. When you slip on the ice and break your leg, you say you have had an accident. But Dame Nature would say that you failed to keep the balance required for walking, and so gravitation, which is always pulling everything towards the earth, had its chance at you. People used to call the unusual Nature happenings accidents, and so they are from the human point of view. But within the last fifty years we have come to believe that there are no accidents in Nature's kingdom. It is not that her laws are being broken, but that the beautiful balance of forces which she usually maintains is being disturbed.

WHY DO WE HAVE AVALANCHES?

Do you remember the fable in which the sun and the wind disputed as to which was the stronger? They set for themselves as a test that each should try to make a traveler take off his coat. Wind tried first. He blew and blew, but the man only wrapped his cloak closer about him. Sun's turn came next. He sent his hot rays down, and in a very few moments the man threw off his cloak and tossed it over his arm. Sun and wind were then working against each other, but often they work together, and when they do they accomplish wonders.

Up in the great snowfields on the mountains, where the snow falls for weeks in the winter, sun and wind are always at work. In Alpine regions the Swiss mountaineers have a proverb that the south wind "eats up the snow." In all seasons, even in the coldest period of the winter, masses of snow, carried away by their own weight, roll from the summits and slopes; these avalanches, however, are merely composed of surface snow, and their effect is trifling.

Many more avalanches would descend on the peaceful mountain valleys if it were not for the sun and the wind. When spring comes in the mountains, the melting begins. Torrents pour down the mountain side, and pools imprisoned under masses of snow and ice escape to join rill or brook. In every ravine, every depression of the ground, this hidden work goes on. But the sun and the wind cannot eat up all the snow, and the tunneling work of flowing water often weakens the upper surface and makes it more likely to slip. Then huge masses of snow slip from the heights and cast themselves into the valleys, burying houses and villages in their headlong rush. Standing at a distance and watching one of these avalanches on a neighboring mountain, one sees an enormous bed of snow plunge forward like a cataract, and lose itself in the lower stages of the mountain.

Whirlwinds of powdered snow, like a cloud of bright smoke, rise far and wide into the air. Then when the snow cloud has passed away and the whole region is again calm, the thunder of the avalanche is heard resounding far below through the gorges. When a field of snow does loosen anchorage, the mass moves with terrific force, carrying before it the trunks of trees, stones, and even huge blocks of rock.

BURIED FOUR DAYS IN SNOW

What the fire-damp is to the miner an avalanche is to the mountaineer. It threatens his home, his barns, his cattle, and it may swallow him up also. Many lives have been lost in these snowslides, but there have been many thrilling escapes. One such story from Switzerland is worth telling. On a spring night a sloping bed of snow, higher than the tallest fir trees and the village tower, fell down, burying a group of cottages and barns. Rescuers hurried to the spot, fearing that their friends had been crushed or smothered. Still they set to work bravely at digging through the snowy blanket. Four days and four nights they labored, and finally they heard voices singing. They found that by great good fortune the houses had withstood the shock and weight of the avalanche, and the air which they contained had been enough for the long wait. While locked beneath the snow the people had managed to dig tunnels from one house to another, and kept on singing to cheer themselves.

TREES FOR A DEFENSE

Two sorts of avalanches are distinguished in the Alps: those known as *poudreuses*, or "powdery" avalanches, and those called *avalanches de fond*, or "of the bottom." The former is a combination of freshly fallen snow and whirlwinds, which sweep down the mountain side with terrible violence, and are much dreaded; the latter are sliding fields, slower in movement, and not so much feared. Thickly planted trunks of trees are the best defense against avalanches, because the snow which has fallen in the wood itself cannot shift its position, and affords a barrier; and when the masses from the bare slopes hurl themselves against the trees, they are usually unable to break through these strong sentinels. A number of villages possess no other means of defense against the snow. We can easily understand with what respect and veneration the villagers regard their protecting woods. Woe to him who touches a forest trunk with his ax! "He who kills the sacred tree kills the mountaineer," says one of their proverbs.

The inhabitants of some villages in the path of avalanches, where trees are not sufficient, try to find a substitute in long stakes or piles driven into the ground to resemble fir trees. This is what they call "nailing up the avalanche." Again, they hew giant steps at given intervals, making a kind of staircase, so that the snow falling from the cliffs may be broken up or partially arrested in its sweep. Walls, too, are built, and new woods cultivated. In these ways man has largely overcome this enemy.

WHAT ARE WHIRLWINDS AND CYCLONES?

Wind is a beneficial nature force when it is quiet and well-mannered. But when wind gets

AN AFRICAN CYCLONE: A TWISTER

in a violent mood and begins to run riot across the face of the earth, there is trouble for all living creatures. In "The Earth a Storybook" we have seen that winds are caused by difference in the temperature and therefore in the weight of air. Cyclones and whirlwinds are great eddies made by winds blowing in all directions towards a place of low air pressure. These

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CYCLONE WRECK AT SOUTH OMAHA, NEBRASKA

winds as they blow in towards this center get caught in a mad whirl, and spin round and round like a top, keeping this movement as they travel across the country.

Many regions are visited by destructive winds which spin like a top, and gathering up dust or water, look like gigantic funnels. Over the country or ocean they race in a mad spiral, uprooting forests, wrecking houses and ships, and leaving death and ruin in their wake. These terrific winds are known by various names — hurricane, typhoon, cyclone, and tornado. Tropical lands are their favorite haunt, and some paths of the sea are noted for their visits. A tiny revolving tornado may be seen on almost any hot summer day, when little columns of dust, only a few inches wide and a yard or so in height, run spinning along the road in harmless riot.

A WESTERN TORNADO

Magnify this motion a million fold and you can imagine what one of our western tornadoes must be. Ferrel, in his fine book on the subject of the winds, describes a tornado that occurred on April 14, 1886, at St. Cloud and Sauk Rapids, Minnesota: "The tornado struck the Mississippi River at a point opposite to the village of Sauk Rapids, and fishermen who were in full view of the crossing say that for a few moments the bed of the river was swept dry; and in proof of this remarkable statement they showed me a marshy spot where no water had been before this event took place. Two spans were torn away from the substantial wagon bridge below the rapids, one span being hurled up the stream and the other down it by the rotary motion of the blast, great blocks of granite being also torn bodily out from the piers. The large flour mill near the bridge was leveled. The depot of the Northern Pacific Railroad was demolished, and the central portion of the village itself was attacked with the greatest violence. Being the county seat, the courthouse was located here, a substantial structure, of which only the vault, six iron safes, and the calaboose were left, the latter turned upside down. A fine new schoolhouse, costing $15,000, was completely swept away. The Episcopal church was so utterly ruined that the sole relic thus far found is a battered communion plate. . . . Stores, hotels, a brewery, and four-fifths of the residences in the village were scattered as rubbish along the hillsides or borne away for miles through the air."

HOW A CYCLONE IS MADE

The valley of the Mississippi is peculiarly subject to these violent tornadoes. At certain seasons this river is very much warmer than the surrounding lands. From its surface water vapor is mounting, and this is condensed by the surrounding cold air. Thus a channel of rare-

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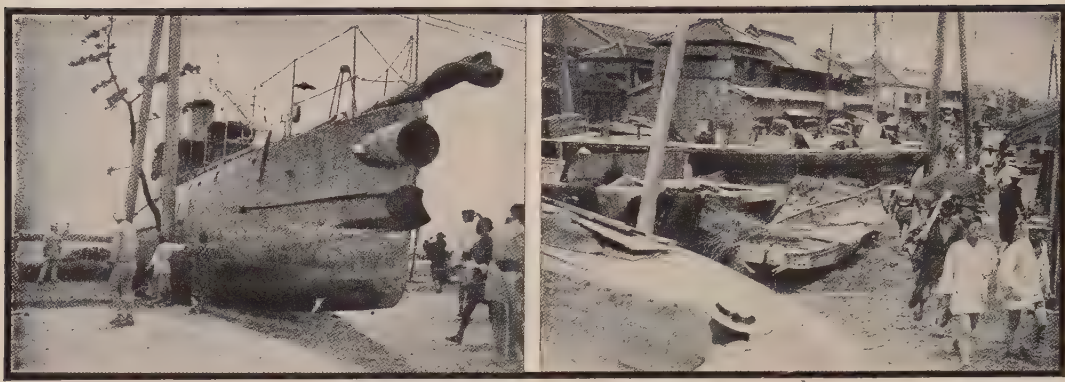
IN THE TRAIL OF A CYCLONE



TORPEDO BOAT FLUNG ASHORE AND BOATS LANDED IN THE STREET IN TOKYO, JAPAN, BY TYPHOON

fied air hangs over the Mississippi Valley, and like the corresponding channels over the ocean currents it becomes a storm track. The same phenomenon may take place in an arid region such as we have in the West. The surface of the earth is heated intensely by the summer sun. Layers of air immediately above the ground are warmed, and so become lighter than the colder layers higher up. Usually the heated layers will rise gradually and the heavier air come down; but once in a while, perhaps on a breathless day, a heavier layer of air may be floating on one that is lighter. The heavier layer descends with a circular rush, and a cyclone is born.

TORNADO REGIONS

Tornadoes occur more often in the United States than in any other section of the globe, and the month of May seems to be their favorite period, although they have appeared in April, June, and July. Occasionally one will whirl in winter down in one of the Southern States. Between 1870 and 1890 about sixty-five destructive tornadoes took place in this country, involving great loss of life and property. Racine, Wisconsin, was the scene of one of the worst. In March, 1913, the Middle West and South were swept by cyclonic storms that left a wide wake of ruin and death. The city of Omaha, Nebraska, suffered the most at this time.

A hurricane in the West Indies, or a typhoon in the China or Indian Sea, is a similar example of wind forces, though they are generally less violent in character than the western tornado. The latter is lightning-like in velocity, and its speed is the despair of men who measure the blowing of the wind. Tornadoes travel over a narrow path, as a rule, concentrating their power in a funnel, the middle of which is a mighty vacuum that sucks up everything in its way. Cyclones and the other whirlwinds, on the contrary, spread out over vast expanses, and so their fury and damage are lessened somewhat. A tornado seldom affects an area more than about five hundred feet in breadth and some thirty miles in length, while the cyclone may reach a width of from two hundred to five hundred miles.

Hurricanes are familiar visitors to the West Indies, the southern parts of the Indian Ocean, the Bay of Bengal, and the China Sea, and each of these regions has its special hurricane season. Thus, of three hundred and sixty-five West Indian hurricanes on record between the years of 1493 and 1885, two hundred and forty-five occurred in the month of October, when the sun has passed south of the line. In the Indian Ocean, also, cyclones are most numerous after either the vernal equinox or the great heat of summer. Typhoons in the China Sea arrive with the "changing of the monsoons." Monsoons are winds which blow in one direction for six months at a time, April to October, then change to blow for the remainder of the year in an opposite direction.

One remarkable thing about cyclones should be noticed. Those in the northern hemisphere always whirl contrary to the movement of the hands of a clock, while those in the southern

hemisphere whirl in the opposite direction. This observation led to a rule of the sea, which has enabled many a ship to ride in safety beyond the track of an oncoming cyclone: "Facing the wind, the center or vortex of the storm lies to the right in the northern, to the left in the southern, hemisphere."

HABITS OF CYCLONES

Hurricanes and typhoons usually start over the ocean because of the great amount of water vapor which, on condensing, makes heat that warms the air and causes it to rise rapidly. They develop in the tropical zones and pass towards the temperate zones. The path followed by Atlantic hurricanes is usually across the West Indies, along the shore of the southern Atlantic States, and then out to sea. Sometimes they visit the Gulf coast and even the Great Lakes. The typhoons of the Pacific Ocean have several paths, some of which cross the Philippine Islands.

WHIRLWINDS IN THE DESERT

Wind is always at work on the shifting sands of the desert, but when a violent wind arises it is liable to do great damage. It catches up the loose sand and whirls it round, causing choking, blinding dust storms. Sand is blown great distances by these storms. After severe whirlwinds, sand from the Desert of Sahara has been found in central Europe, and on ships far out to sea off the African coast.

DESTRUCTIVE FLOODS

There are some sections of our country in which the rivers are expected to overflow their banks when the spring freshets come. It is strange that people will continue to live where there is frequent danger of having their houses swept away; but they do, just as they live in the path of avalanches and in earthquake and cyclone and swamp-fever regions. Sometimes the floods are of unusual char-

A SAND STORM IN THE DESERT: MEN AND ANIMALS MUST BURY THEIR FACES FOR PROTECTION

acter. The year 1913 will be remembered as one of the most disastrous of recent flood years, not only in our country, but in England and France. The pictures which we give of the floods in Ohio indicate the destruction of property, but can give no idea of the terrible scenes in which hundreds of men, women, and children lost their lives, or of the heroic incidents of rescue. The beautiful city of Dayton, Ohio, suffered most severely, and it will be

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THE FLOOD IN PARIS

A steamboat quay on the Seine, in front of the Louvre. Floating pier alone above water.

many years before full recovery can be made from the ruin brought upon business and homes in a few hours, when the rushing waters of the Miami poured over the banks and embankments, swept away the strong stone bridges that were supposed to be indestructible, and turned what had been a crowded business and residence section of a city into a stretch of boiling waters from one to three miles in width. At about the same time, the Hudson rose high above the safety mark, and the city of Troy, New York, had its river section under several feet of water, and much damage was done also at Albany, the state capital. In the great flood of 1910, when the Mississippi rose to a raging lake in Louisiana, as shown in our picture on page 145, more than six hundred lives were lost at the point where the photograph was taken. In time, progress in engineering will probably reduce the peril from flood, and the cities in special danger from this cause will be made as safe as human skill and genius can make them. It was necessary, apparently, that thousands of people should lose their lives, and millions of dollars' worth of property be destroyed, before men would see the folly of living in peril from the elements.

OTHER SUDDEN CHANGES IN NATURE

Nature happenings which are sudden and cannot be predicted are always terrifying and liable to be dangerous. The more we learn of Nature's laws, the more we are able, however, to foresee these events. Eclipses of the sun and moon ceased to frighten when the time of their appearance could be calculated. But the changes of which we have been speaking, and the changes in the earth's crust, with its accompanying earthquakes, tidal waves, and volcanic eruptions, will always carry danger even when they are better understood. We can take precautions against them. We do not build our houses on volcanoes, and we try to avoid districts where flood and drought are probable. But no amount of understanding ever prepares us for these disasters. Geologists knew that San Francisco was in an earthquake belt, but that did not lessen the horror of her catastrophe. It had been pointed out many times that parts of Dayton, Ohio, were built on land formations which were in many places liable to floods, but the flood was hardly less appalling when it came.

Still it increases our confidence in Nature to know that all these happenings are not haphazard accidents. We become more grateful for the wonderful interweaving of these laws of the universe which works out the harmony of forces in the midst of which we live.

IN A FLOOD-SWEPT CITY OF OHIO. LOWER VIEW SHOWS THE MAIN BUSINESS STREET THE WEEK AFTER

WHILE THE WATERS RAGED

When a flood like this sweeps suddenly down upon a city, only the upper parts of buildings remain above the rushing waters.

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HOME WRECKED BY FLOOD AT AUSTIN, TEXAS

The daughter of the family is guarding the property, while her father hunts for valuables. This is a striking illustration of the total destruction of property by the muddy waters of a flood, which makes it practically necessary to start the home anew, the old furniture being worse than useless.

CAVES

SINCE the days when the first men who lived on the earth, exploring their surroundings, found in the rocks chambers and caverns ready hollowed out for their homes, caves have had a great fascination for mankind. There is a strange mystery about them. To go underground into a series of winding passages not made with hands, leaving behind the familiar world of sunshine and everyday activity, is to experience a mysterious awe and dread which will continue as long as human nature loves light and color and avoids darkness.

The real story of caves is as wonderful and absorbing as any fairy tale. Most of these rugged chambers are carved out of rock by underground water. In its journey through the earth the water gathers up quantities of carbonic acid which comes from the decay of animal and vegetable matter. Dead leaves and fallen branches of trees furnish a great deal of this acid. So the water takes it on its travels, and the acid eats away the rocks, especially those of limestone. The most remarkable caves in the world are in limestone regions.

THE WORK OF UNDERGROUND WATER

After a while these underground rivers seek new fields of activity and vanish, leaving behind the record of their work. Sometimes a whole gallery of caves has been worn away in the solid rock. But such a process takes countless ages, and is never finished. Water trickles into the ground above the cave roof, and passing through the porous limestone carries with it a tiny particle of a chemical called carbonate of lime. Drop after drop of the water leaves behind it on the cave roof a bit of whitish substance, which is the larger part of the lime it held. This is the beginning of a stalactite. If stalactite is a word that has no meaning for you, imagine an icicle of white stone slowly growing downward, grain by grain, until it reaches the size of a tree trunk! The drops of water also deposit a mite of lime on the floor of the cavern, and little by little they build a stalagmite, which grows up to meet the stalactite. Perhaps hundreds of these are being formed at the same time in a vast cave. There are few sights in the world more amazing than one of these underground galleries filled with dead-white columns and groups of immense stony needles. The pictures will show you the difference between stalactites and stalagmites.

FAMOUS CAVES

The Adelsberg caves in the Alps are famous for their stalactites, and also for the torrent that roars through the principal cavern there. But this whole district, which extends to the

GNOMES IN THE CAVES OF ROMANCE

east of the Adriatic between Laibach and Fiume, is the most remarkable in Europe for caves, underground streams, and abysses. The whole surface of the country is pierced with deep, boat-shaped cavities, at the bottom of which water may be seen in a kind of whirlpool. Many mountains here are fairly honeycombed with caverns and passages. The most curious part of the Adelsberg labyrinth is that which ap-

pears to have been the former bed of the Poik River. It affords wonderful groups of stalactites, especially in the "Salle du Calvaire," which has a vaulted roof of two hundred and ten yards' span that has let down a forest of ghostly columns.

Many extremely interesting remains of the "cave man" and long extinct animals have been found in the grottoes of Europe, England, Australia, and America. They throw light upon the early history of man and the changes brought about in animal life and climate. One of the earliest caves to be examined in a scientific way was that of Gailenreuth in Franconia, Germany. Beneath the stalagmite floor were found immense quantities of animal remains, including the bones and teeth of the lion, hyena, grizzly bear, mammoth, and reindeer, all of which had long ceased to exist in that region. In the celebrated cave at Wookey Hole in the Mendip Hills, England, signs of the presence of man were found. These consisted of an oval implement of flint, very roughly made, a short arrowhead, and some fragments of chipped flint, together with two bone arrowheads. Then better utensils of early man's making came to light in other caves, showing the progress of his civilization; and in caves of Spain have been unearthed wall paintings of animals done in rude colors.

CAMPBELL'S HALL, LURAY CAVERN, VIRGINIA: STALAGMITES AND STALACTITES ARE CLEARLY DEFINED IN THIS BEAUTIFUL CAVE

THE MAMMOTH CAVE

The famous Mammoth Cave in Kentucky is the largest of all. It might be called a subterranean world, having a system of lakes and rivers, and a network of galleries and passages without number, which cross and recross one another, going down to an immense depth. There are some two hundred miles of alleys, the actual length of the cave being estimated at one hundred and fifty miles. The average height and width of the passages are reckoned at seven feet. No less than twelve million cubic yards

of material have been gradually excavated by the slow wearing of carbonic-acid-laden water through the rock. The cave once served as a retreat for savage tribes, for skeletons of an unknown race have been found buried in it under layers of lime.

Of the highest interest are the strange creatures that at present live in the Mammoth Cave. First among these is a curious small fish, about five inches long. It is white, but its most striking peculiarity is its complete blindness, which is attributed to its having been cut off from the light of day for generations. To make up for this loss, the little fish has extraordinary powers of hearing and feeling. It is difficult to catch and very rapid in movement. A small blind crayfish also inhabits this cave, and there are wingless grasshoppers, and two queer, sightless species of beetle. Both in the Mammoth and Adelsberg caves small eyeless spiders have been caught. All of the creatures found living in caves are usually colorless, weird specimens. This excludes naturally all those birds and beasts, like owls and foxes, that simply hide and sleep in such places or drag their victims there.

Sea-hewn caves must not be forgotten, as some of them are very remarkable. Nearly all of us have seen gigantic waves break upon a rockbound coast and tear away at the stone. The fury of Atlantic storms has carved out the beautiful cave on the Island of Staffa, Scotland, which in ancient days was supposed to be the work of Fingal, the demigod, and it bears his name. Among the Orkney and Shetland Islands there are magnificent examples of the architecture of the sea in the shape of underground tunnels, caves cut inland for considerable distances.

THE CAVES OF OCEAN

Caves may be due to volcanic action, or to the violence of an earthquake. But the most familiar are those eaten out by the slow, gentle action of water. Perhaps the best examples of caves thus produced are the hollows and excavations so often seen at the base of inland cliffs. Sometimes these are merely the result of century-long wear of frost, rain, and heat. The stupendous effects of such prolonged weather action alone are best seen in the rock shelters of the cliffs of New Mexico and Colorado, where the mysterious cliff dwellers made their homes, like eagles, in the face of forbidding walls of stone, which appear to be unscalable.

THE BLUE GROTTO, AT CAPRI, THE SOUTHERN ENTRANCE TO THE BAY OF NAPLES ITALY

THE DESCHUTES RIVER CAÑON, OREGON

BURIED TREASURE

MOTHER EARTH buried her treasure long, long ago, and her children have been finding it ever since. There is never a year when inquisitive man does not come upon some form of it and bring it to light. She was not like the pirates of other days, who buried their treasure on desert islands and left no sign of its whereabouts, lest someone besides themselves come upon it. Mother Earth put her riches in the ground for her children to find. She made the earth a great storehouse of wealth, which they might draw upon as soon as they knew how to use it, and she left many signs on the surface by which they might find out her secrets.

MINERAL WEALTH

One of the wonders of the world is the vast amount of mineral wealth stored away under our feet. Until we stop to consider, we do not realize how dependent we are on minerals. Think of the numbers of ways in which we make use of them in our daily life. We use metals for tools, for machines, as rails for our railroads and wires for our cables and telegraph and telephone connections. Half the machinery of our modern civilization is made from metals, fashioned by heat and pressure into thousands of forms. The gold supply of the world is hoarded and watched over with the greatest care, for all our system of money exchange depends upon it. The finding of a great gold field may at any time affect the scale of prices all over the world.

Man would have been less comfortable and much slower in his progress in civilization if he had not found in the earth stores of energy in the form of beds of coal, supplies of oil, petroleum, and natural gas, asphalt for his pavements, and peat for his fuel. He could never have built his fine cities or carved his wonderful statues and monuments if he had not discovered beds of granite, marble, sandstone, and other building stones. What a terrible loss it would have been to the world if the Greeks had not had marble with which to put into enduring form their dreams of beauty! The moment when men first worked in stone marked the

beginning of a permanent memorial kept from one century to another.

Besides these more useful substances there are precious stones and gems, diamonds, sapphires, and rubies, the topaz, the emerald, the beryl, the opal, and the garnet, which Mother Earth has tucked away in her veins for her children to come upon with delight.

HOW DO WE GET METALS FROM THE EARTH?

Metals are found in rocks, either free, in their pure state, or combined with other substances. If there is enough of a metal in a rock to make it worth our while to get it out, we call the rock ore—an iron ore, copper ore, or the like. These mineral ores occur either on the surface of the ground, when they can be obtained by simple quarrying, or in veins and deposits at various depths underground, when they must be mined. The story of how mining is done belongs with industries; but it is interesting to know that from the earliest times of which we have any knowledge, some form of mining has been practiced. The Egyptians, the early Britons, and the Romans were all experienced in mining. But the introduction of steam power within the last century has revolutionized the methods of mining. Only since we could work in the rock, with the force of steam helping us, have we been able to take metals from the ground in large quantities with great speed.

In thinking of our underground wealth we should remember that we who live in the twentieth century are the most favored people who have ever dwelt on the earth. We have the tools and the scientific knowledge to find and make use of more of these hidden riches than

OLD MAN'S ISLAND, CUTLER, MAINE, SHOWING THE UPRIGHT LAYERS OF ROCK

any earlier generation. New stores of wealth are also being opened up in our day. The Chinese have always feared any attempt at mining, because they believed that a powerful dragon lived underground who would be angry if he were disturbed. Now the great natural resources of China are being developed.

IRON, THE KING OF METALS

Iron is the most useful and necessary of all metals. For that reason, as we like to think, Mother Earth has placed it in almost every country and made it easier to get than any other metal. But its own properties are responsible for its kingship in the mineral world. Iron owes its place chiefly to its hardness and strength. It will stand almost any test or pressure, from the weight of a heavy train rolling over its rails to a tempering and refining for the thinnest knife blade.

One of the most interesting ways of dividing the history of the world into periods is by the kind of tools employed and the power acquired over the mineral kingdom. When a tribe stopped making its implements of stone and began to work in iron, it went up a long step in the ladder of civilization. It passed from the Stone Age to the Iron Age. The Egyptians and Babylonians used to call iron "the celestial metal," probably because it is very common in the meteors which fall from the sky. In the poems of Homer, iron is spoken of as something rare and precious, which was stored in the treasuries of the rich, and on one occasion a lump of iron was offered as a prize to be given at the games. Greeks and Romans used iron for weapons, pointing their spears with them; and Romans, Celts, and Britons had iron swords. One writer tells of Cæsar's ships being much inferior to those of the Britons, because the oak timbers of the northern ships were fastened together with iron pins "as thick as a man's thumb," and iron chains replaced rope cables.

WEAPONS OF THE IRON AGE FOUND AMONG VARIOUS PEOPLES

If our own time could be given any one name to rank it in civilization, it might be called the

Age of Steel. Steel is so much more valuable for practical purposes than iron, that while more iron is mined than ever before in the history of the world, the object of most of this mining is to produce material for manufacturing steel. Bessemer's discovery of a simple way to manufacture steel has gradually transformed the machinery of the world. In the production and manufacture of steel the United States stands head and shoulders above any other nation. In the middle of the nineteenth century Germany had produced more steel than America; now the United States has a yearly output of more than twice as much as that country.

Our greatest iron fields lie in the Lake Superior region, and in Missouri, Alabama, and Pennsylvania, though iron ore in smaller quantities is found in many sections of the United States. So important has the industry of iron and steel become to this country that it has been described as "a sort of barometer of trade and national progress."

THE NEXT MOST IMPORTANT METAL

To say that of all the metals dark, heavy iron is the most precious is surprising enough, but for second in value, if not first, we should certainly expect to put gold. The ancients would have done this. Of the six metals which they knew — iron, copper, tin, lead, gold, and silver — they put gold and silver highest. But to us copper is even more precious than gold. This does not mean that a coin made of copper would be worth as much as a coin made of gold. Gold has a value beyond its simple worth as a metal, because it has been made the standard of the world's coinage. But for a useful metal copper stands very high in the list.

Do you know what daily, almost hourly, use you make of copper? Probably you think you do not depend on it at all; but you do. Copper is one of the best conductors of electricity. The wires of telephones and trolley lines are made of this reddish metal, which is very strong, and easily worked. So we Americans are very fortunate to have what are probably the richest copper deposits in the world. It is found in its free state in the Lake Superior region, and in combination with other minerals in many western states. Besides its use for copper articles, like wires and boilers and cooking utensils, copper is an important part of brass, bronze, and gun metal.

WHY IS GOLD USED FOR COINS?

If you were asked why gold is used for money, you would probably give as your reason that it is very valuable. But why is it valuable? It is beautiful, to be sure, but other metals are beautiful. It is rare, but not so rare as some of the newly discovered elements, like radium or helium. Is it only because gold is the money standard of the world that it is so prized? No, for back of that is the reason why it was chosen for coins. Iron and copper are precious because they are so useful; gold, because it does not rust when left exposed to the air. This makes it safe for coinage, because it is of permanent and unchanging weight. The water in the air acts on iron and steel and rusts them. Sulphur, of which there is always more or less in the atmosphere, acts upon silver, covering its surface with a black coating which is called sulphide of silver. This is what we rub off when we clean silver, and we also rub off each time a little bit of silver which has gone into the coating. But gold is not affected by the air, and so it is invaluable for exchange. As a metal for coating or gilding articles, or for rings or vessels, it is special, aside from its beautiful luster, because it can be hammered into very thin sheets. We should call one hundredth of an inch thin. Gold leaf is hammered to $\frac{1}{282,000}$ of an inch.

OUR NATIONAL MINERAL WEALTH

If we went on through the list of metals, we should find that the United States is exceptionally rich in almost every one. It contributes yearly the second largest amount in the world to the supply of silver, with Mexico standing first. It leads the world in zinc and lead, comes second in gold, and furnishes large amounts of almost every known metal. Much of the prosperity of the United States depends on its underground wealth, and of this we have touched only a small part when we speak of the metals, for the minerals which are non-metals are immensely valuable. The most important nonmetal is coal, of which we mine at present more

TURQUOISE MINING AT NISHAPUR, PERSIA

than any other country. Great undeveloped coal beds exist in China, Peru, Alaska, and other eastern lands. We have also some of the richest oil fields in the world, and we furnish more than half of all the petroleum which is produced. We make more salt than any other nation, and still have not enough for our own use. We have great treasures in building stones, and so the story might go on, showing in every case what a wonderful country we live in.

PRECIOUS STONES AND GEMS

Gems are always fascinating. Cut and polished as we see them in jewelry, they catch light and reflect it, and give a wonderful play of color. But if they are wonderful in their finished form, how much more wonderful it is that these beautiful rock crystals are tucked away in hard, unlovely rocks of wholly different kinds. The Latin name for gem, *gemma*, means also a bud, as if these were buds in the rock which would blossom forth in the hands of the jewel cutter as a bud comes up from the dark ground and becomes a beautiful blossom.

WHAT MAKES A STONE PRECIOUS?

A perfect gem-stone must have three qualities — beauty, rarity, and endurance. A real precious stone of the first order could never wear out. As we tell the story of some of the most famous gems, you will see that it is not an idle fancy that gems which are being worn at the present time may have been worn three and four thousand years ago by Babylonian kings or Egyptian ladies. It is a strange thought that the life of a gem, like the life of Mother Earth herself, is infinitely more stable and enduring than that of any living creature.

The beauty and value of gems depend mainly on their color. This may mean color in the sense in which we ordinarily use it, of being red like a ruby or garnet, or it is more likely to refer in the broader sense to their power of reflecting light. The diamond has no color of its own, but it reigns supreme in the kingdom of precious stones because of its marvelous "fire," sparkling with every movement from brilliant blue to glowing red. Other colorless stones, like white sapphire, topaz, and rock-crystal, reflect light brilliantly, but none of them glow like the diamond, with gleams of hidden fire. In some stones the color is so fixed as to remain constant in all lights; in others, the shade changes under artificial light. But the color of stones is what has given most of them their names.

Because we human beings are made as we are, we also set great value on anything which is rare. If diamonds were as common as their near relative in the mineral kingdom, coal, we should take them for granted and not prize them so highly. It is because gems are tucked away in the rocks and are rare and hard to find that we count them of so much value.

HOW CHILDREN FOUND THE WORLD'S GREATEST DIAMOND FIELDS

Boer children at play, and an African shepherd boy, were the ones to bring to notice the world's greatest diamond fields. In ancient times India was the diamond center of the world. In the eighteenth century Brazil took its place. Then in 1867, seventeen years after the discovery of gold in California, the children of a Boer farmer, Daniel Jacobs, living on a river bank in South Africa, picked up in their play a pebble which was destined to mark a new epoch in diamond mining and change the whole history of South Africa.

These children, playing in the shallow water, gathered up handfuls of pretty stones and took them home for playthings. One which they showed to their mother was so bright and of such peculiar shape that she suspected that it might be worth something. She happened to mention the find to a neighbor, Van Niekirk, who asked to see it. But the children had lost it, and it was not until after a long search in the yard that it could be found. Van Niekirk agreed with Mrs. Jacobs that it looked as if it had some value, and offered to buy it. But the family would not hear of taking money from a friend and neighbor for a bit of rock. They laughed at him and told him to "sell it and make his fortune."

THE TRAVELS OF AFRICA'S FIRST DIAMOND

The stone contained a fortune, but the trouble was that no one would believe it. Van Nie-

SOME OF THE FAVORITE GEMS

1. Chrysoberyl. 2. Tourmaline. 7. Black opal. 3. Moonstone. 4. Amethyst.
5. Turquoise. 6. Zircon. 8. Fire opal. 9. Cat's eye.

kirk turned it over to a trader, John O'Reilly, who was to dispose of it and give him half the profits. O'Reilly took it up to Hopetown, but was laughed at by everyone to whom he showed it. All admitted that it was an unusually pretty stone, and of a queer shape, but they thought it merely an odd rock-crystal. Still O'Reilly could prove that it would do things that no other stone in South Africa would do. It was so hard that it would cut glass, and O'Reilly cut his name in more than one window pane in Hopetown for the benefit of admiring groups of spectators. This should have made them suspect what it was, for it is one of the most familiar properties of a diamond that it is hard enough to make a mark on glass.

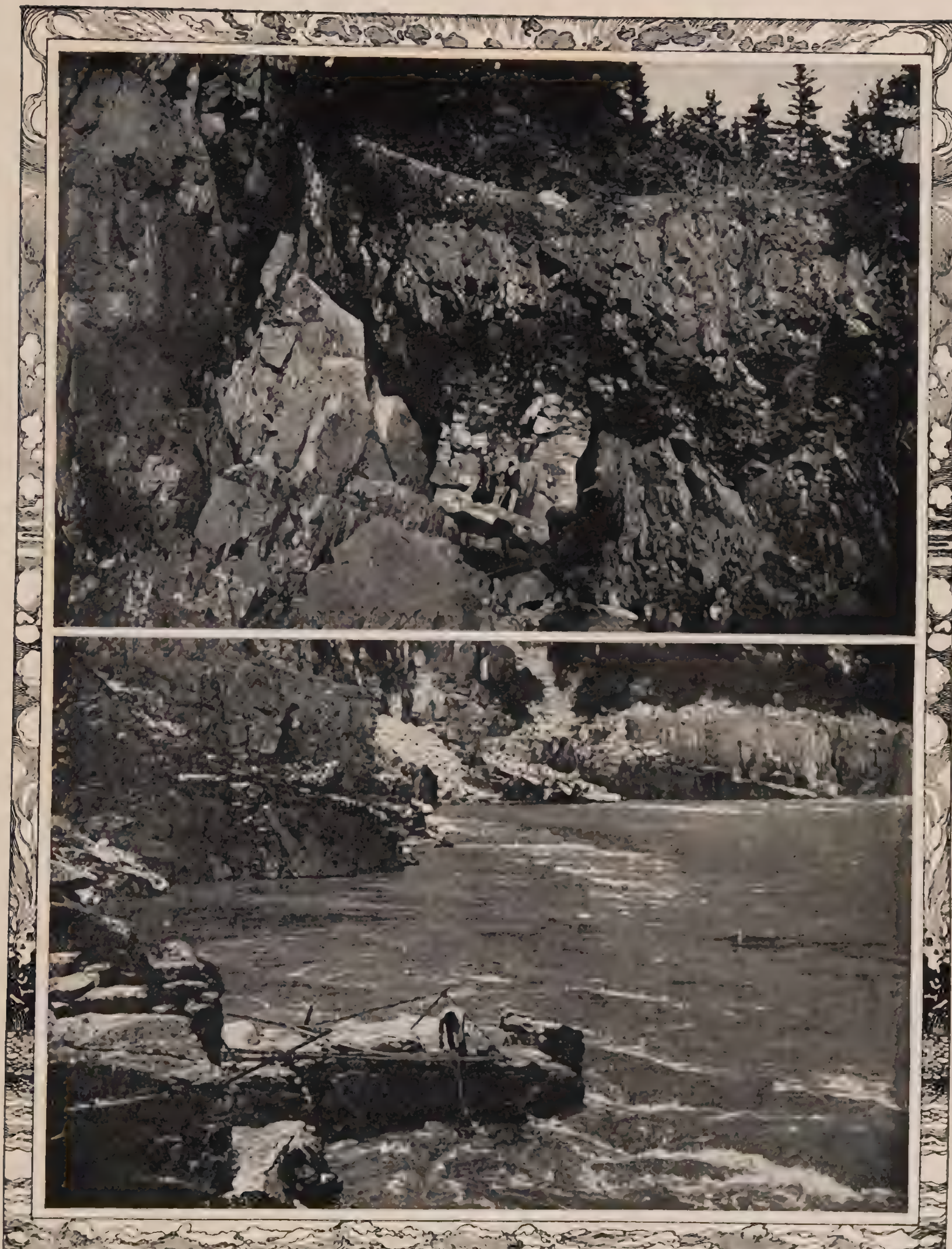
Finally O'Reilly gave it to an English official, who agreed to send it to a mineralogist, but had so little idea that it was of any special value that he sent it off in an ordinary gummed envelope. The mineralogist tested it and found that it was a fine diamond, weighing twenty-one carats. The diamonds which we usually see in rings weigh from half a carat to a carat. So this was a really valuable one. The mineralogist took it to the English governor, who bought it for twenty-five hundred dollars and sent it to the Paris Exhibition of that year.

Still no one believed that this was more than a stray diamond, such as had been picked up in many remote parts of the world. But Van Niekirk kept his ears open for more tales of strange stones, and two years later he heard that a shepherd boy on a farm near the same river had found an even bigger stone. Van Niekirk hurried to the spot and purchased the stone from the boy for five hundred sheep, ten oxen, and a horse, which was to the boy untold wealth, but not worth one tenth of the fifty-six thousand dollars which a Hopetown firm paid for the stone. In London it would have brought even more, for this was the famous "Star of South Africa," weighing in the rough uncut state eighty-three and one-half carats.

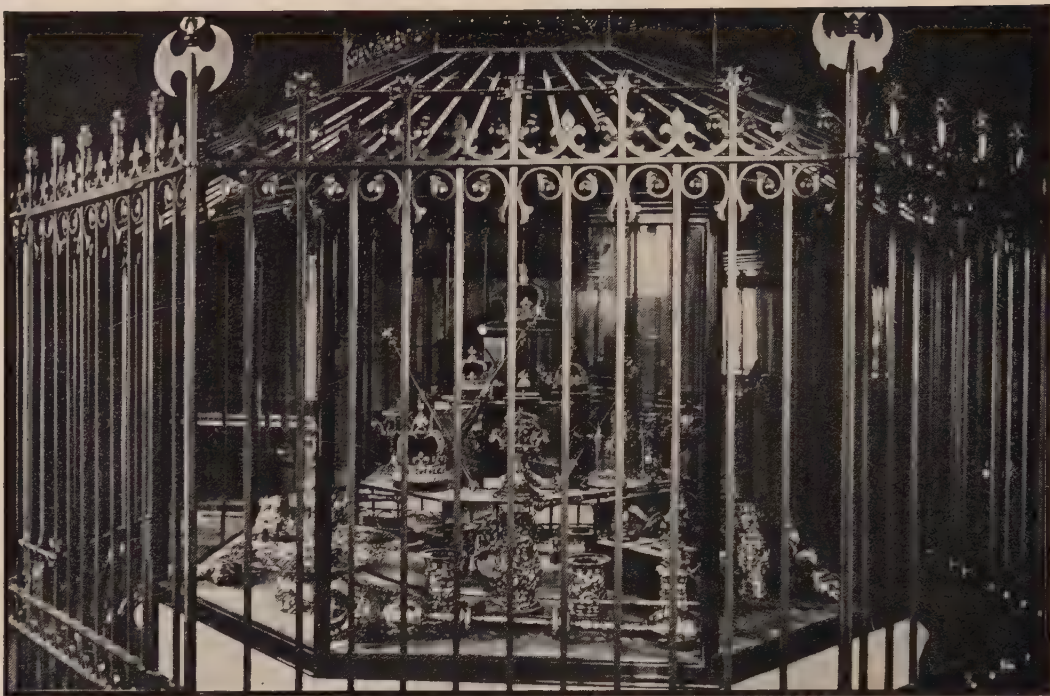
FAMOUS DIAMONDS AND THEIR JOURNEYINGS

Diamonds which when cut weigh more than one hundred carats are so few that their history is kept just as the history of families and nations is followed. These treasures have played no small part in the molding of history. Diamonds have been pledged for ransom, and their possession has changed the outcome of wars by supplying wealth at a needed time. The story of precious stones is one of the most romantic chapters of history.

The old mines of India were the source of most of the gigantic world-famous diamonds, and of these none is more celebrated than the



ABOVE: NATURAL BRIDGE, CUTLER, MAINE. BELOW: CATCHING SALMON, FRASER CAÑON, CANADIAN ROCKIES



CROWN JEWELS OF ENGLAND IN THE TOWER OF LONDON

These jewels, of vast value, are many of them on the crowns of the sovereigns.

Koh-i-noor, meaning "Mound of Light." Its actual history can be traced back to the year 1304, when it was in the possession of the Mogul emperors; and legends carry it four thousand years back of that. It passed into the hands of the Persian conquerors of India in 1739. In 1850 it came to the East India Company, in whose name it was presented to Queen Victoria. It has since been the private property of the British royal family, and is kept in the Tower of London.

The Pitt diamond, which is the property of the French government, was found in India by a slave who concealed it in a hole he cut in his leg for the purpose. He escaped to the coast with it and offered it to a sea captain on condition that he take him to a free country. It passed through the hands of a Parsi merchant, was bought by an English governor, sold to the Regent of France, stolen during the French Revolution, and then restored by the thieves, who probably had no way of disposing of so famous a stone without detection.

One of the finest diamonds in existence, the Orloff, forms the top of the imperial scepter of Russia. It was once one of the eyes in a statue of Brahma, in an East Indian temple, and was stolen by a French soldier. He sold it for ten thousand dollars to the captain of an English ship. It was then sold in turn to a London dealer, and a Persian merchant. This fortunate man sold it to Prince Orloff of Russia for the fabulous sum of four hundred and fifty thousand dollars and a yearly income of twenty thousand dollars for the rest of his life. Prince Orloff presented it to Catherine II of Russia.

THE LARGEST DIAMOND IN THE WORLD

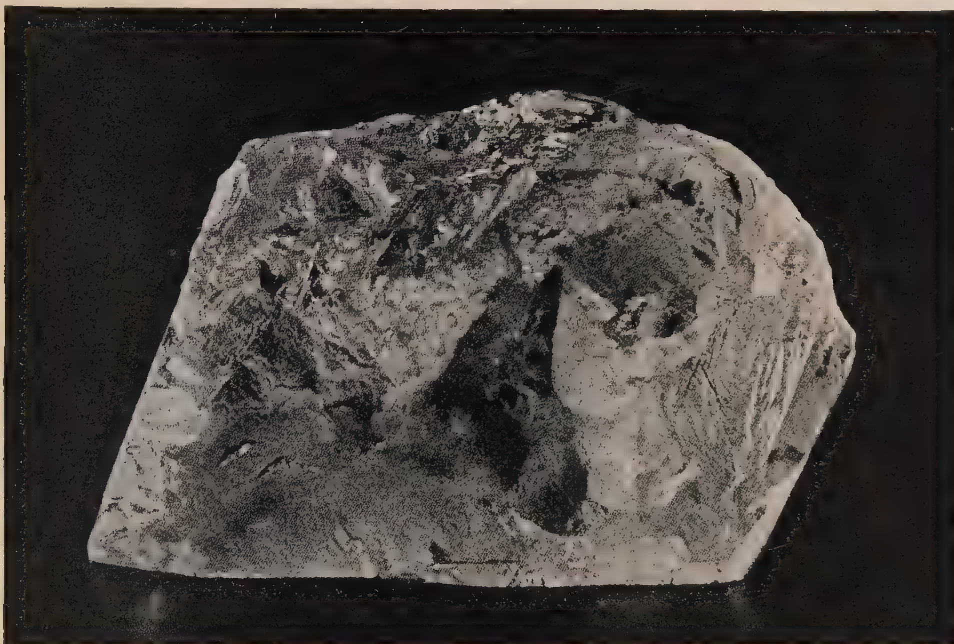
The heaviest diamonds previously found are small when compared with the colossal Cullinan, or Star of Africa, which came to light in South Africa, in 1905. This diamond, a picture of which we give in its original form, has been cut up since its arrival in England, and the stones belong to the crown jewels of Great Britain. In its rough state the stone

weighed over three thousand carats, about a pound and a third. It was purchased by the Transvaal government for seven hundred and fifty thousand dollars, and presented to King Edward VII on his birthday.

OTHER PRECIOUS STONES

Precious stones played an important part in all ancient history. Not only were they prized for their worth, but they were believed to have special virtues and to bring good or ill fortune to their possessors. Until within a couple of hundred years these stones have been valued almost as much for the mysterious powers which they were believed to possess as for their beauty.

Oriental kings often retained their thrones by keeping in their control regions rich in precious stones, which brought them a yearly revenue. The ruby mines of upper Burma were jealously guarded by generations of Burmese kings. The Cleopatra emerald mines of Egypt were lost for many centuries, but were re-discovered by a recent English viceroy. When the Spanish conquered Peru, they seized thousands of emeralds from the temples and private treasure chests. The natives bitterly resented their barbarous treatment by the Spaniards, and refused to tell where the mines were from which the gems were taken, and it was a long time before by diligent search the invaders came upon one of the Colombia mines, which has been worked almost continuously during the four hundred years since the Spanish entered South America, and has yielded vast rewards.



CULLINAN DIAMOND, THE "STAR OF AFRICA"

New stores of precious stones are discovered every few years. In 1889 a hunter, tracking a wounded kangaroo in New South Wales, happened to pick up a beautiful opal. The region was so dry and barren that it would not have been explored except by some such chance; but thousands of opals were tucked away in the seams of the rocks.

So there are many chapters in the Wonderbook of the Earth which have not been read as yet. The interest is always keen to penetrate as far as possible into Mother Nature's mysteries, and gain what we can of knowledge and of hidden treasures.

A MARVEL OF NATURE'S WONDERLAND

Not only are the strata standing on end, but they run in colossal and graceful curves. On the right is a stone monument carved by water, with the aid perhaps of some earth-shudder or gigantic wrench. Below is one of the famous natural bridges, in the Alps, with tourist accommodations close at hand.

By courtesy of Travel

NATURAL BRIDGE IN THE ALPS: PREBISCHTHOR AND HOTEL

PONT DE L'UNIVERSITÉ, LYONS, FRANCE

This bank of the Rhone commands a view of the Church of La Fourvière, the University, formed of a group of imposing buildings on the eastern bank, and the Hotel Dieu or Hospital.

THE KIND OF BRIDGE MODERN MAN BUILDS COMPARED WITH NATURE'S MODEL

Natural bridge known to the Indians as Nonnezoshi (the stone arch), the largest natural arch yet found, measuring 308 ft. in height and 275 ft. between the abutments. It spans the cañon which extends from the slopes of Navajo Mountain northwest and joins the Colorado River.

NATURAL BRIDGE, NAHANT, ON THE MASSACHUSETTS COAST

Courtesy American Museum of Natural History

ANIMALS OF THE WHARF PILES

THE SEA AND ITS MARVELS

THE STORY OF WINDS AND WAVES, TIDES AND CURRENTS, SAND AND SHELLS; OF MARINE LIFE AND MONSTERS, AND ALL THAT IS IN THE DEEP

THE sea has always been a marvel and a mystery to man. Vast and limitless beyond anything which he knew, with depths which he had never fathomed, it stood to him for something beyond himself, that he could neither measure nor conquer.

Man might travel across the ocean in his tiny ships, but he left no trace behind him. It was still the pathless deep. He might study its waves and explain them, and its tides and tell their cause; but when he was through, there was the sea, vast, sublime, and majestic, untamed and untamable.

> "In all time,
> Calm or convulsed, — in breeze or gale or storm,
> Icing the pole, or in the torrid clime
> Dark-heaving; boundless, endless, and sublime —
> The image of Eternity, — the throne
> Of the invisible; even from out thy slime
> The monsters of the deep are made; each zone
> Obeys thee; thou goest forth, dread, fathomless, alone."

In myth and legend the world begins always with water. Earth was pictured by the ancients as an island set in the midst of an encircling ocean. Indian myths say, "In the beginning all was water; there was no land at all." And science tells us that this is true. In the beginning our planet was covered with water. Only gradually the earth's crust rose and fell, from the great upheavals in its burning center, and formed the continents and islands which make up a third of its surface.

Life began in the sea. That is the most wonderful thought of all. We think of life as belonging naturally to the land. It is only within a few centuries that we have come to know very much of life under water. The ancients pictured strange sea-monsters, serpents and harpies, half human and half creature, dwelling in the deep. But of the wealth of actual life in the sea they had no idea. Pliny, the Latin writer, counted one hundred and seventy-six kinds of creatures which he found in the waters of the Mediterranean, and was sure he had told them all. In the aquarium at Naples to-day you could probably see as many thousands. And so the ocean has come to mean more to us than it could to our ancestors. We have not lost our awe and wonder; they have only deepened as we have learned more. But we have come farther into its inner chambers. It has shown us more of its secrets. To us more than to any people

A MAN-EATING SHARK, INDIAN OCEAN, 18 FEET LONG

who have ever lived on the earth the wonders and treasures of the deep have been laid bare.

THE COLOR OF THE SEA

The usual color of sea water is a pale bluish green, but a sudden gust of wind, a dark cloud, a blue sky, animal or vegetable life, as well as the nature of the sea bottom, give it almost every possible color at times.

The greenish color of shallow water is due to the yellow of the sand shining through the natural blue tint of the water. The degree of saltness as well as the depth of the water affects the richness and hue; thus, the waters of the trade wind region, rich in salt, are dark blue, while the fresher northern seas are strikingly light green. The Mediterranean generally appears a very deep azure, or sky blue, due doubtless to the sunny sky looking down into it, and the Gulf Stream can be readily distinguished by the deep indigo of its waters.

Besides these different colors in the open sea, certain areas have peculiar colors due to local causes. Thus the Yellow Sea, off China, is named from the color given to its waters by the vast amount of mud brought down by the great rivers emptying into it. The Red Sea takes its name from the reddish tint along its coralline shores. A reddish color has been noticed in the South Atlantic, off the mouth of the La Plata, as well as in certain parts of the Pacific. Sometimes the waters of the Gulf of Guinea are whitish, while in the northern seas, off Greenland, streaks of green and blue are striking.

THE EVER RESTLESS SEA

One of the things that strike you as you look upon the ocean is the fact that it is never absolutely still. Even when there is not a breath of air the waves come gently lapping on the sands. Then, when the wind blows high, waves rush towards the shore to break with a roar upon the beach. While man has not been able to invent a machine that would go forever without stopping, the sea shows him incessant motion.

OCEAN WAVES

Of the three movements of the sea — waves, tides, and currents — the waves are the most familiar. There are always ripples on the sea, because there is always at least a slight movement in the air, since, wherever the gentlest breeze strikes the water at an angle, it makes a little depression. This depression in one place is followed by a rise in another. This rising and falling of the sea surface makes the waves. Now, the waves move up and down, and not onward, like ocean currents. Strange as it may seem, waves are as fixed almost as a buoy. They do not travel. The waves of the Atlantic Ocean so plainly appear to be going out to sea, that we feel disappointed to be told, for the first time, that they will never reach the coast of Europe or Africa; that, in fact, they are anchored with a cable no force of wind or wave can break.

It is only the motion that is passed on from wave to wave. One wave strikes another, the second strikes a third, and so on, and so a

wave motion is set up. This is made plain by watching a tablecloth shaken by two persons standing some feet apart. While waves are seen in the cloth, the cloth itself is a fixture. We see only the motion that passes along the threads of the fabric, from one end to the other. Try it for yourself.

THE BIGGEST WAVES

Waves forty-three feet high have been measured in the North Atlantic Ocean. In the South Atlantic, off the Cape of Good Hope, they have been reported fifty and sixty feet high. The height of an ordinary wave with only a moderate wind is about six feet from crest to trough. In our study of light waves we have learned that wave-lengths are reckoned from the top of one wave to the top of another. Sea waves have a wave-length varying from ten to twenty times their height. Waves four feet high will have their crests about forty feet apart; those thirty-three feet high about five hundred feet apart.

A BRAVE MOTHER WALRUS

Though wounded herself, this mother walrus is trying to protect her baby from the harpoon of the hunter.

THE SALT IN THE SEA

Everyone who has bathed in the sea knows that its waters are very salt and somewhat bitter. To explain where the salt came from has been an age-long puzzle. Even yet many hold that it came from the rivers, and that they are still supplying salt to the sea; but this view is now given up, and it is generally agreed that the waters of the ocean have been salt from the beginning. When all the waters of the seas were still in a state of vapor, or steam, because of the earth's fierce heat, the salt existed in them also in a state of vapor. When finally the earth became cool and the vapors condensed into drops and fell as water to form our seas, the salt came down with the rain, and the seas have been salt ever since.

WHAT IS SEA SALT?

Yet the salt of the sea is not merely our common table salt. It contains many other substances, such as magnesia, iron, lime, sulphur, copper, potash, ammonia, and silver, in actual amount small only in comparison with the salt. For example, although the proportion of silver contained in sea water is so little, the ocean itself is so immense that, it has been calculated, if all the silver of the sea were collected, it would form a mass that would weigh about two hundred million tons.

It was knowledge of the presence of this silver and other mineral grains in the sea water that made it possible for an ingenious swindler to lead many people to believe that gold could be gotten out of sea water in quantities large enough to make all the stockholders in his company rich. But all the gold he got out of the stream of sea water drawn through his secret mill on the Maine coast was what he put in, as the unfortunate folks he deceived finally found out.

The saltness of the ocean varies considerably in different parts. Near the equator, the great heat carries up a larger proportion of water by evaporation than is done in the cooler

WAVES BREAKING ON A ROCKY COAST

regions; and thus, since salt is not removed by evaporation, the ocean in the torrid zone is salter than in the temperate or the frigid zone.

It is because salt makes the sea more dense that salt water is more buoyant than fresh water. This is a great advantage in the matter of ocean commerce. Since a ship of given height does not sink so deep in the sea as it does in fresh water, a vessel can carry more cargo on salt water than it would be able to do on fresh water. Again, because of the greater support afforded by salt water, it is easier to swim in salt water.

CAN WE GET THE SALT OUT?

One great disadvantage in the saltness of the sea is the unfitness of its water for drinking. Every seafarer has had occasion to recall those famous lines in Coleridge's "The Ancient Mariner":

> "Water, water, everywhere
> And all the boards did shrink;
> Water, water, everywhere,
> Nor any drop to drink."

Since that time we have learned to get fresh water from salt water by distillation.

Once a ship's captain lost his whole supply of fresh water by accident. Before he could put into port and get a fresh supply, a gale of wind, which lasted for three weeks, drove him far out to sea. He had no distilling apparatus on board. He would have to invent some way to get the salt out of the water or die. So he took an old iron pitch-pot with a wooden cover for a boiler, made a pipe of pewter plate, used a wooden cask as a receiver, and set to work. He filled the pot with sea water, put in an ounce of soap, thinking to purify it, and placed it on the fire. When the pot began to boil, the steam passed through the pipe into the cask, where it was condensed into water. The salt particles, which do not evaporate at the boiling point, were left behind in the pot. In less than an hour the crew had a quart of fresh water to drink.

Many ships are now regularly supplied with apparatus for distilling sea water. In case of emergency, while on the African coast and other unhealthy stations where water is bad, the sailors drink no other water than that distilled from the sea.

THE TIDES

Whether you have ever seen the ocean or not, you have certainly heard how its waters creep steadily up the beach for six hours and then for six hours slip as steadily down the beach, all in answer to some mysterious, unseen force. The cause of this endless rise and fall of the sea is still much of a puzzle; but it is pretty well agreed that the rising of the water, the "flow of the tide," is brought about through the ocean being drawn forward, as it were, out of its place by the influence of the moon. It is drawn through that force of nature called "attraction," much as a loadstone or a magnet draws a needle to itself.

If you throw an apple up into the air it will fall back to the earth and not fly off into space, because it is drawn to the earth, just as a needle is to the magnet, by this same force of attraction. Birds cannot fly beyond the earth's power of "holding." This force of the earth, which draws everything to itself, is called "gravitation."

WHY FOUR TIDES A DAY?

Now all bodies have more or less of this power of attraction, measured by their size and distance. The moon has it, and so has the sun. But the sun, for all its size, is so much farther off, that at 93,000,000 miles from the earth it does not attract so much as does the moon at 240,000 miles. The moon draws up the great wave of ocean, which is called the "tide." The tide caused by the sun is so small as to be noticed only when the sun and moon both act on the water at once. The tides ebb and flow twice in twenty-four hours. This is because the earth goes round on her axis in that time, and brings the same point of the ocean twice under the direct influence of the moon.

Twice in the course of every month the sun and moon come into a line with each other. This happens at new and at full moon. At these times both attract at once; that is, they

WAVES OF THE OCEAN WHICH TOSS LIKE A FEATHER THE HEAVIEST WARSHIP OR STEAMER

draw together. At such seasons the tides rise high and are called "spring tides."

But when the sun and moon act in opposite directions, "draw apart," the water is low, and is called "neap tide," or "scanty." Neap tide occurs at the end of the first quarter of the moon and at the beginning of the third.

The height of the tide is affected also by other causes; thus, a strong wind coming in with the tide will drive on the waves madly. When the sea rushes in with such power as to do much damage, it is spoken of as a "storm tide." Along the flat coasts of the Netherlands the storm tides are a particular dread. In these low-lying countries, from far inland is heard the roar of the waters. On comes the flood, bursting dikes and sweeping all before it, towns and villages and fertile lands, to bury them in the sea.

MAP OF CURRENTS IN THE SEA

RIVERS IN THE OCEAN

Do you ever go surf-bathing in summer? Is the water warm or cold? If you go in at Atlantic City, or anywhere along the New Jersey coast, you will find the water comfortably warm. But if you go in at Squirrel Island, a hundred miles east of Portland, Maine, you will find it very cold. What makes the difference? It is the same Atlantic Ocean, is it not? Yes, but there is a broad stream of warm water, flowing like a river in the midst of the ocean, that warms up the Jersey coast's wonderful sand beach.

A BATTLE BETWEEN CURRENTS

This mighty ocean-river, or current, is that Gulf Stream which starts in the torrid heat of the Gulf of Mexico, down near Panama, where the great canal is. Warmed by the sun of the tropics, it flows up the Atlantic coast, carrying with it warmth and genial weather. But just off the coast of Maine it meets another of the ocean-rivers. This is an icy cold one, called the Arctic current, which starts from the north pole and flows down between Greenland and Labrador, laden with icebergs and floe-ice. Now when the Arctic current reaches the coast of Maine, it hits the Gulf

Stream. Then there follows a great battle (where the black spot is on the map). The icy polar current wins the day, casting its chill on land and sea. The Gulf Stream is forced off into mid-ocean. Presently it divides; one branch is driven towards Europe, the other along the western coast of Africa. Thus the Gulf Stream goes winding on its own proper route, with as distinct a source, course, and service as the Hudson River or the Mississippi. Before it has made its way back to its own warm gulf again this ocean-stream makes a journey of twenty thousand miles.

If you look on the map of "Currents in the Sea," you will notice that the ocean is full of these currents, cold or warm, each after its kind. And strangely enough, even though in the torrid zone the water is so warm on the surface, underneath it is frigidly cold, owing to the polar current flowing under the Gulf Stream.

DEPTHS OF THE OCEAN

Deep-sea sounding shows the average depth of the ocean to be about two and a quarter miles. The seas are shallower than the oceans, and, of the oceans, the Arctic and Antarctic are the shallowest. The deepest sounding thus far made is in the western Pacific Ocean near the Ladrone Islands, where the depth is shown to be 31,600 feet, nearly six miles.

It is of interest to recall that the highest mountain, Mount Everest, is 29,002 feet; so that there is less than 3,000 feet difference between the earth's greatest elevation and her deepest ocean-bed.

WHERE LAND AND WATER MEET

When we speak of the depth of the ocean we mean its depth at some distance out from shore. Just as at one beach the shore slopes off gradually and at another the drop is very abrupt, so about some continents there is a great shelf running far out under the water. Such a shelf, seventy-five to one hundred miles broad, extends along the eastern coast of North America from Newfoundland to Florida, and around the shore of the Gulf of Mexico and part of Central America. The shelf on the Pacific borders is rather narrow; the British Isles rest on a high northern shelf. When these shelves are in latitudes where there is a cold climate, they make the world's best fishing grounds. The great Newfoundland fishing banks are on such a wide land formation. Beyond the edge of these shelves the waters suddenly deepen and the real ocean basin begins.

THE BOTTOM OF THE SEA

While the ocean forms one continuous body of water, it is divided into five smaller bodies, — the Pacific, Atlantic, Indian, Arctic, and Antarctic oceans. These are all formed by very deep depressions in the ocean floor. The Arctic and Antarctic oceans are marked off from the others by their location around the north and south poles. The other three are separated mainly by continents. Of the entire water area of the earth the Pacific fills about one-half, the Atlantic one-fourth, the Indian Ocean one-fifth, and the Antarctic and Arctic one-seventeenth and one thirty-fifth.

There is a natural curiosity to know what the bottom of the sea looks like. Suppose the Atlantic Ocean should suddenly dry up, what would a journey across its bed show us? It used to be imagined that the ocean bottom was much like the land surface, with plains and hills, valleys and mountains, and all sorts of grand scenery. But as the students of geology came to know that the present form of the earth's surface is largely the result of those remarkable forces of frost, wind, tide and flowing streams, it was clear that the sea bottom, where these forces are not at work, would be different. Then for many years the deep-sea soundings and the ocean dredging have been bringing us new facts, until we have learned that the sea, away from the shore, is not unlike a gentle, rolling plain. It is said that this sea floor slopes so easily that a railroad could be built upon it without the necessity either of building bridges in any part of its course, as has to be done so often on land, or even of raising the floor to make it level for the rails.

Numerous volcanic cones, such as those that make a broken chain in the North Atlantic from Iceland to the Azores, are everywhere over the sea bottom.

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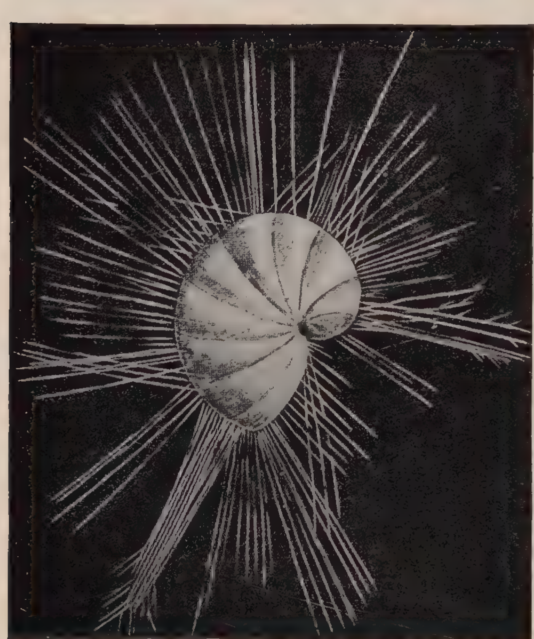
SOFT-SHELL AND OTHER CLAMS

WHAT IS ON THE FLOOR?

The floor of the ocean itself is made up of the many layers brought there by the rivers. For countless ages the rivers of the world have been carrying down particles of earth and rock to the sea. These the ocean currents have taken up and scattered over the ocean floor for an average distance of about three hundred miles out into the sea.

In addition to this deposit brought by the rivers, there is found in the ocean a thick,



A TINY CHALK-BUILDING CREATURE, REACHING OUT THROUGH ITS SHELL IN SEARCH OF FOOD

gray, oozy mud which covers much of the bottom. This ooze is made up of broken particles of shells and skeletons of the animals that have lived in the sea, and especially of the myriads of shells of those single-celled animals that form our chalk. Thus there is forever going on a gentle rain of tiny animal shells from the upper regions of the ocean down into its lowest depths to carpet the ocean floor.

Farther out in the greater depths of the sea is found a red clay which is made up of the dust particles thrown out by the volcanic eruptions which occurred in the sea long ago, even before those old-fashioned sharks lived whose teeth are buried in it — the teeth of extinct creatures that must have lived countless ages ago, here preserved to suggest how very old this world is.

THE DIFFERENCE BETWEEN SEA SAND AND DESERT SAND

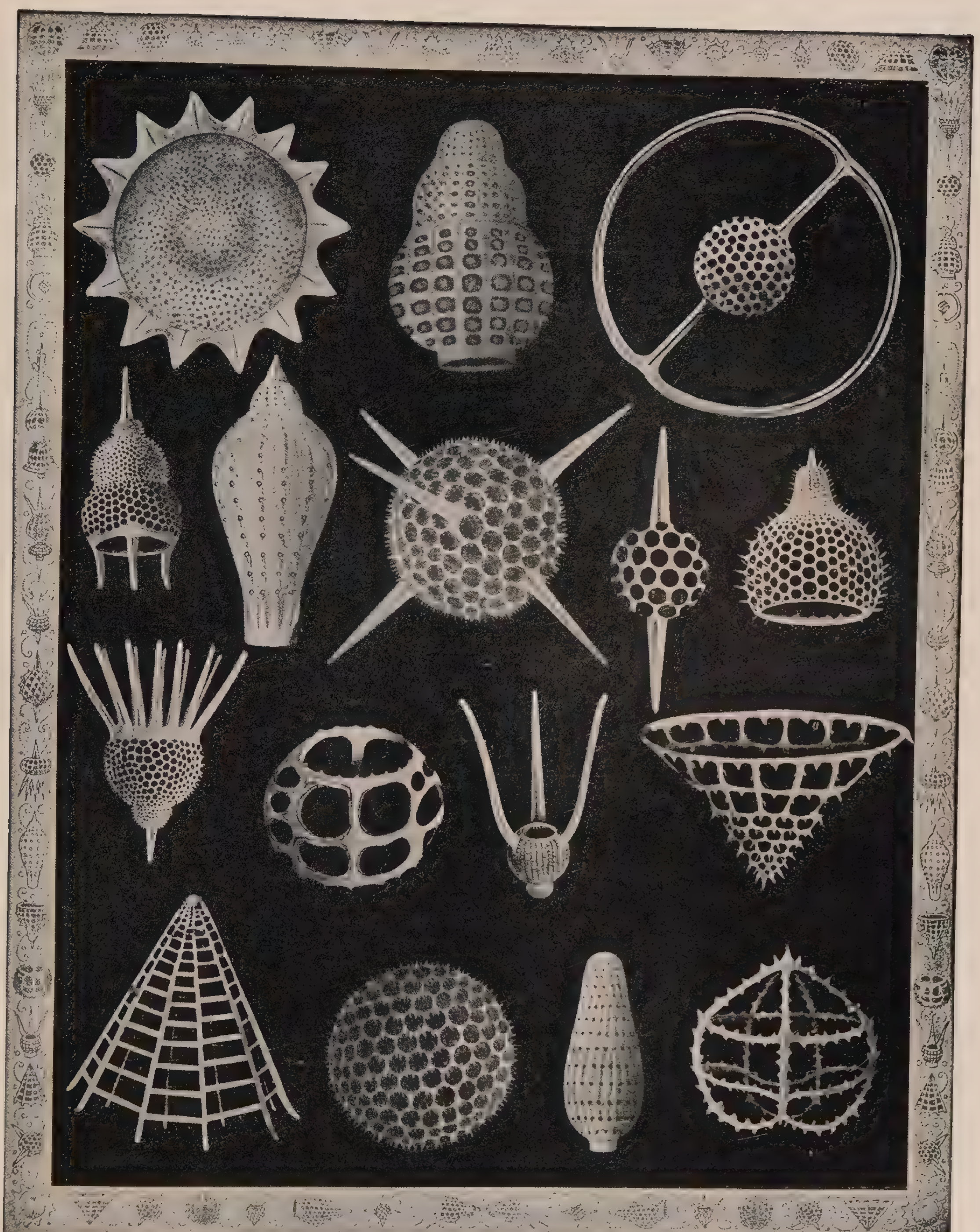
Take a handful of sea sand and look at it through a magnifying glass. You will see that the separate sands are not worn quite smooth and round, as might have been expected, but that the little grains still retain to a certain degree their once sharp angles. This is due to the wet grains, as they lie with their faces towards one another, holding a film of water between them which prevents their actually touching each other, and so grinding down all of each other's angles. If we could go from the seashore to a desert, where the sands are absolutely dry and destitute of any protecting film of water, we should find that the sands of the desert, from being blown about by the wind and rubbing together in the dry air, have become rounded and smooth and are gradually converted into fine dust.

WHAT IS SAND MADE OF?

The magnifying glass told us that sand was made up of sharp-pointed grains. That was as far as anyone could go until the microscope was invented. Now put a dozen of these tiny grains under its strong glass, and see what it will show. A world of beauty will leap forth. Each of these grains is made up of the tiniest of tiny shells, of which it has been estimated that it would take at least a million to fill a lady's thimble. They were once the home of living animals, about which we shall read in the story of life in the sea. Before its life ended each of these animals built for itself a casket of exquisite beauty, which it left behind, and these shell homes form a large part of the countless sands of the seashore.

FRESH-WATER SPRINGS IN SALT WATER

In the waters of the Atlantic, some miles south of Cuba, a fountain of fresh water



GRAINS OF SAND, MAGNIFIED UNDER A POWERFUL MICROSCOPE

The sand of the sea bed is made up of tiny perfect shells so small that to the naked eye they look like powder. Once the home of the lowest form of living creatures, it would take a million of these shells to fill a lady's thimble.

bubbles right up through the salt water of the ocean. There is another off the coast of Italy. In both cases the fresh water comes from springs that are fed from below the ocean-bed. The water of these springs trickles for miles perhaps under the surface of the earth; then, not finding an outlet upon the surface of the land, the spring breaks through the bottom of the ocean. What makes the water rise? As, by nature, fresh water is lighter than salt water, it rises to the surface of the ocean, just as oil floats on the top of water, or cream rises on milk. This rising of the fresh water is further helped on by another of Nature's ways: since the water of these under-ocean springs comes down from greater heights, it is bound to seek to rise as high as its source. And so we have these rare submarine springs, seeming miracles until you think out the reason for them.

WHIRLPOOLS

Certain currents in the sea, called "whirlpools," fill our imaginations with horror. The water of a whirlpool moves round and round in a circle. At the center of the circle a funnel is formed, into which every object caught by the waters of the whirlpool is forcibly dragged, to be sucked remorselessly underneath the water. The most famous of whirlpools is the one off the coast of Norway, known as the *maelstrom*, "the whirling stream." The current of the maelstrom, by running north and south for six hours, then east and west for six hours, produces a whirlpool which is always greatest at "high" and "low" water. During this greatest convulsion of the waters, when the wind is blowing against the current, the maelstrom would engulf any ship afloat.

Other whirlpools occur among the Ferro Islands and in the Gulf of Bothnia.

WATER-SPOUTS AND WIND-SPOUTS

Among the terrors of the sea are water-spouts and wind-spouts. It is hard to tell which is more dreadful.

The wind-spout sucks up the water in the shape of a funnel. The vessel is hurried into the very middle of it, from which there is no drawing back. She is held in the grasp of the waters and seems to be at the bottom of the huge crater of a volcano; nothing but darkness around, overhead a streak of light. Sailors call this dreadful position "the eye of the storm."

Frightful noises stun the ear; the rattling and groaning of the ship, the roar of the waves, and the howling of the wind are heard on every side. Every man expects instant death. Then, when the ship has been sucked in by the wind-spout and has been held suspended there in the air for ages of agony, it seems, she is let go. The furious storm passes on with a roar like thunder. The masts are split and rent, the sailors deafened and half-stunned. But now that danger has passed, let all hands be ready to take a part in repairing the damage done by one of the most awful experiences of a sailor's life.

The water-spout is even more to be dreaded. It appears at first as a deep cloud, white above and dark below. From the lower part of this cloud hangs, or rather falls down, a portion like a tube, or column, tapering as it descends. Under this there is always a great boiling-up of the sea, which in fact ascends in the form of a column to meet that from the cloud. The whole pillar then has a swift, whirling motion, making a noise like that of a mill. This whirling continues until wind or some other cause breaks the column, when the water that has been drawn up descends suddenly with a force and in a quantity to sink any vessel that is under it. When sailors see a water-spout at a distance, they sometimes discharge a gun at it, loaded with a bar of iron, by which it may be broken up.

TRADE WINDS

To say that a person is as changeable as the wind is to forget that, changeable as the wind *seems*, it is under the complete control of natural forces, and travels, not by chance, but in entirely regular tracks.

Winds are due first of all to the fact that heated air has the same tendency to rise over the great torrid belt of the earth that it has in the rooms of our houses. Now, when this heated air of the tropics rises in columns over the torrid zone and spreads north and south toward the poles, the space from which it has

WATER-SPOUTS SEEN IN THE MEDITERRANEAN: A NUMBER OF VESSELS WERE UTTERLY WRECKED

come must be filled up by colder air, since "Nature abhors a vacuum," as we have learned before. This colder air can come from only one direction, from the polar regions. This rising of the heated air of the tropics and the constant filling-in by the colder air from the poles would result in a regular motion, or circulation, of air from north to south. But this regular air-motion is interfered with by several natural causes, the chief of which is the earth's west-to-east daily turning on her axis, which gives our day and night; for, as the winds from the poles come toward the equator, they are outrun and driven out of their course by the swifter-moving earth. Thus, while the earth is going east, the winds lag behind toward the west. The two polar currents meet in the tropics and form one great current which travels from northeast to southwest, called the "trade" or "track wind," because it moves in a regular track. This is the wind that gave Columbus so much anxiety on that first voyage to the New World. He could not but wonder how he would ever get back if this wind always blew in one direction. This, again, is the same wind that Magellan allowed to carry him so magically around South America into the Pacific Ocean.

A BATTLE OF THE WINDS

But, powerful as the trade wind is, it meets forces stronger than itself: the continents turn it aside, the mountains block it completely. In the Indian Ocean it is so broken up that it blows six months one way and six months the opposite. This "reversed" trade is called the "monsoon." It comes about through the vast plains of Asia getting so hot that great columns of heated air rise, leaving a space to be filled up by a rush of air from the equator. These air-columns meet the trade wind with such force as to drive it back and make it take a different course, thus forcing it to blow from the southwest instead of from the northeast, the regular track of the trade in the southern hemisphere. But this change in the trade wind or monsoon does not take place all at once. First the weather becomes unsettled. Then black clouds gather in the sky, followed by flashes of lightning and peals of thunder. The sea grows wild; rain falls in torrents. On land there are awful floods; houses are swept away by the water and the wind; there is loss and suffering everywhere within the monsoon's reach.

THE REGION OF CALMS

This battle of the giants, the Trade and the Reverse Trade, has to be fought over twice a year. Every April, Monsoon wins; every October, Old Trade, but only after war's toll of death and destruction.

The trade winds die out on each side of the equator in what is called the "Region of Calms,"

a more or less shifting zone from one hundred and fifty to six hundred miles wide, according to the longitude and the season. In March the center of the calm-belt is at the equator. Here the air is that dull, dead calm, more dreaded by the sailor than almost anything in Nature; especially after he has been sailing over a flowing ocean, rippled by the welcome breath of the trade wind, the bright blue sky overhead unflecked by a single cloud.

Suddenly comes a change. The sky is overcast. The waves cease to be tipped with silver foam. A belt of heavy cloud overhangs. The winds are hushed; thick vapor rests motionless in the air. The surface of the sea is like lead. The sailor feels oppressed, half-choked by the weight of the air. It takes the poet to describe it:

"Down dropped the breeze, the sails dropped down,
'T was sad as sad could be;
And we did speak, only to break
The silence of the sea.

"Day after day, day after day,
We stuck, nor breath nor motion;
As idle as a painted ship
Upon a painted ocean."

Then, without warning, a furious tempest breaks, a hurricane sweeps round the circle, and the rain pours down in such torrents that the sailors can scoop up fresh water from the surface of the sea.

Such is the Region of Calms, the belt best known for its frightful storms. Happy is the sailor to turn his back on this sad scene, to watch his ship once more plow the waves, driven onward by ocean breezes.

ICEBERGS

The polar regions of the earth are covered with a thick, moving ice-cap, forming "glaciers." The ends of these glaciers are all the time pushing out from the land until they overhang far into the sea. In time, as these overhanging parts are beaten by storms and worn upon by the action of the water, great masses are broken off. Thousands of these fragments, broken off from the southwest coast of Greenland, are caught and held for a time by the floe-ice in the land-locked waters between Baffin's Bay and Greenland. When the southwest wind unlocks the Arctic gates, these fragments of glaciers break from their moorings and sail southward, a magnificent fleet of hundreds of icebergs. While the greater part never get farther than the Labrador coast and northern Newfoundland, a small number, helped on by wind and current, make their way into the Gulf of St. Lawrence or sail on to the southward, to be watched for by anxious sea-captains, as the single remaining terror of all those monsters, real and fabled, that once filled the sea.

What hope has any ship moving at the rate of twenty-two knots an hour against a mass of ice rising to a height of a hundred feet, reaching down to a depth of a thousand, and extending over the sea for a mile? The *Titanic* answered, *None*.

But are there no other icebergs than those made by the Humboldt Glacier in the Greenland berg-factory? Yes, more and larger ones are built by the Antarctic glaciers. The reason we hear so little about these and about the few and smaller ones of the North Pacific is because they seldom make their way into the great traveled ship-roads of ocean, owing to the small help they get from ocean currents. The Arctic Current and the Gulf Stream are responsible for the yearly menace of four months of iceberg in the North Atlantic during shipping's rush season.

WHAT MAKES THE SEA SHINE?

Some dark night, when you are out rowing in the smooth water of a sheltered cove, you will be startled to see a streak of light follow each stroke of your oar and then to see that the drops falling from your oar look like a shower of pearls and diamonds. Looking back you will see that the boat leaves behind it a streak of flashing light and that all about is a shining, myriad-colored radiance that makes of the whole surface of the water a fairy moving-picture indeed.

Do not be content merely with being told that this wonder-coloring is due to phosphorescence; but, with a dipper, scoop up a quart of the sea water, take it to the light, and see for yourself the million dots of color, each not

ICEBERGS AND THEIR PERILS

The view at the top shows the *Titanic* taking her last plunge after striking the iceberg, and carrying down over fifteen hundred persons to death. The bottom pictures show on the left a great field of ice, with detached icebergs; and on the right such an ice mountain as the *Titanic* struck.

larger than a small pin-head, which make up some of life's simplest children called *Noctilucæ*, "night glows." They are single drops of shine which give out sparks of light from below their outer rim. It is estimated that there are thirty thousand to a cubic inch of water containing these one-celled light-givers. Now conceive the millions upon millions in this sea, covered for miles with this glow of liquid fire!

You may ask, How do these animals give out light? Some say it is caused by a chemical change in their delicate organs, while others tell us that these creatures, although they can be scarcely seen with our eyes, have a wonderful power of changing the heat of their tiny bodies into light.

LIFE IN THE SEA

SO far we have talked about the ocean as if it were, as the ancients thought it, a vast stretch of water, inhabited only on its edges by living creatures. In just this way an inhabitant of another world might describe the formation of the earth, in mountains, valleys, continents, and so forth, and never think to mention what to us would be the most interesting thing of all — the life on the earth. It would be just as unfair to describe the ocean without showing it to be a world of abounding life.

The tiniest and the largest forms of life of which we know exist in the ocean. There are the infinitesimally small one-celled forms of life, so tiny that we can see them only under a powerful microscope, and there are the huge sea animals and fishes, larger than any creatures now living on dry land. So there is no better or more fascinating place in which to study life than in the ocean.

Everywhere, throughout every body of water, in all parts — above, near the surface, between, in the numberless fathoms of water, and below on the ocean bed — living creatures flourish in numbers past imagination. There are barren regions, where there is comparatively little life or very few kinds of life, even as on the earth we find deserts and waste lands; and there are tropical waters that throng with life. There are water creatures that travel from place to place; and creatures that are fastened to their rock and sand homes and can never stir. But everywhere there is life, and life of a particularly fascinating sort, because, while some of it is familiar to any seashore child, other kinds belong to water regions of which we should know nothing if it were not for the pictures and stories that deep-sea students bring us.

LIFE'S SIMPLEST CHILDREN

Countless hosts of animals live in the sea, creatures about which nothing was known until the compound microscope was able to show them to us. To such animals a drop of water is a complete world, for it may contain millions of creatures so small that they have to be made to look a thousand times as large as they actually are before the eye of man can see them. This is the wonder-work of the microscope, the instrument made up of lenses so combined that it magnifies a creature the size of the tiniest pin-point, showing it to be a living thing, moving, eating, and producing more of itself by a simple dividing up into two.

THE SEA HORSE

A tiny fish, only a few inches long, which looks like the knight in a set of chessmen. It swims in an upright position and looks as if it were walking on its tail.

If you will slice up some raw potato in a cup of soup left from dinner and let the mixture

stand a week or two you will find under the microscope, in a single drop, more marvelous forms of animal life than the greatest scientist knew about until the microscope was invented a little over a hundred years ago.

TWO WAYS TO ADD TO OUR EYESIGHT

There are two wonderful instruments we use to see with. One is the telescope, which opens to us the book of the heavens; the other is the microscope, which reveals otherwise hidden pages of the earth's storybook. Both have a word story in their names. Telescope comes from the Greek words *teleos*, or "far-off end," and *skopos*, "view." Through the telescope, then, the distant planet is brought nearer to our sight. The microscope is exactly the opposite in its effect. The Greek word *mikros* means "little," or "small," so that this instrument gives us the "little view."

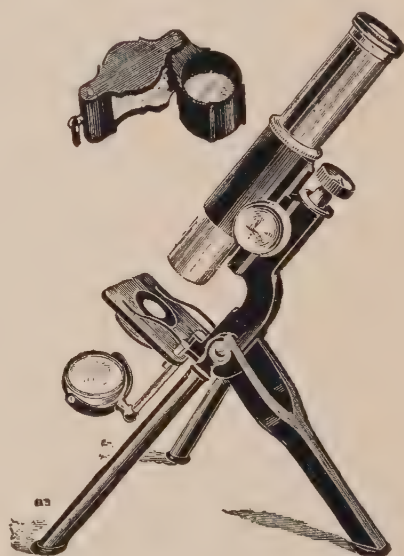
A DROP OF STAGNANT WATER MAGNIFIED

THE INHABITANTS OF A DROP OF WATER

In a drop of sea water examined under a microscope fifty animalcules were found, in each square of the micrometer glass, or each eight hundred and fortieth of a square inch; and as the drop occupied a circle on a plate of glass containing 529 of these squares, there must have been in this single drop of water about 26,450 animalcules. In a gallon of water there would be more of these tiny living creatures than there are human beings on the globe. It gives a wonderful picture of the minuteness of creation, when we think of more than twenty-six thousand animals living, obtaining food, and moving perfectly at their ease, without annoyance to one another, in a drop of water. About one hundred and fifty millions of animalcules would have abundant room in a tumbler of water.

PROTOZOA

These creatures belong to what scientists call "Protozoa," which means "first animals." They are the lowest of the eight groups into which the several hundred thousand different sorts of living animals are divided. Among the Protozoa, those that exist in untold millions in decaying animal or vegetable matter, whether in salt water or fresh, from the torrid to the frigid zone, are called "Infusoria," and are the smallest and most numerous creatures in the world. The monads are the smallest of all.



LABORATORY AND POCKET MICROSCOPES

The bodies of the Infusoria are transparent and of all sorts of shapes. One of the commonest

COLONIES OF PLANTLIKE ANIMALS

found in the potato infusion is the slipper animalcule, which you will easily recognize by its shape; another, the flower animalcule, is known by its bell-shape raised on a slender, more or less curled stem, a number bunched, as it were, in a colony. Then the night-glow, the Noctilucas, which makes the sea look like liquid fire on a dark night, is another of the Infusoria.

HOW ONE CELL BECOMES TWO

Though a hasty glance might lead you to think that the Infusoria are mere tiny bags of water, they are in truth capable of doing all any creature need do to live and to pass on its life. They have a crude sort of way of getting their living food, which they draw into a funnel-shaped hollow lined with hairs called "cilia." They have a breathing-sac, a round clear spot, which is ever changing from large to small and small to large. They have a small dark spot, half of which goes with each new creature when it becomes two by self-division. Who can say which is mother, which daughter, of these two new ones?

The Infusoria move so rapidly with their "cilia-motors" that your eyes will ache from trying to keep them in sight as they race and chase about, literally thousands of them in their single drop of water.

Besides this method of self-division, the Infusoria, under certain conditions, send off germs or eggs. So that if the actually living Infusoria were all killed, there are countless millions of chances of having a full supply even while you watch.

A PIECE OF CHALK

Besides the Infusoria there are other sorts of Protozoa that you have been acquainted with as long as you have used crayon; that is, if the crayon you used on your blackboard was old-fashioned and made of chalk.

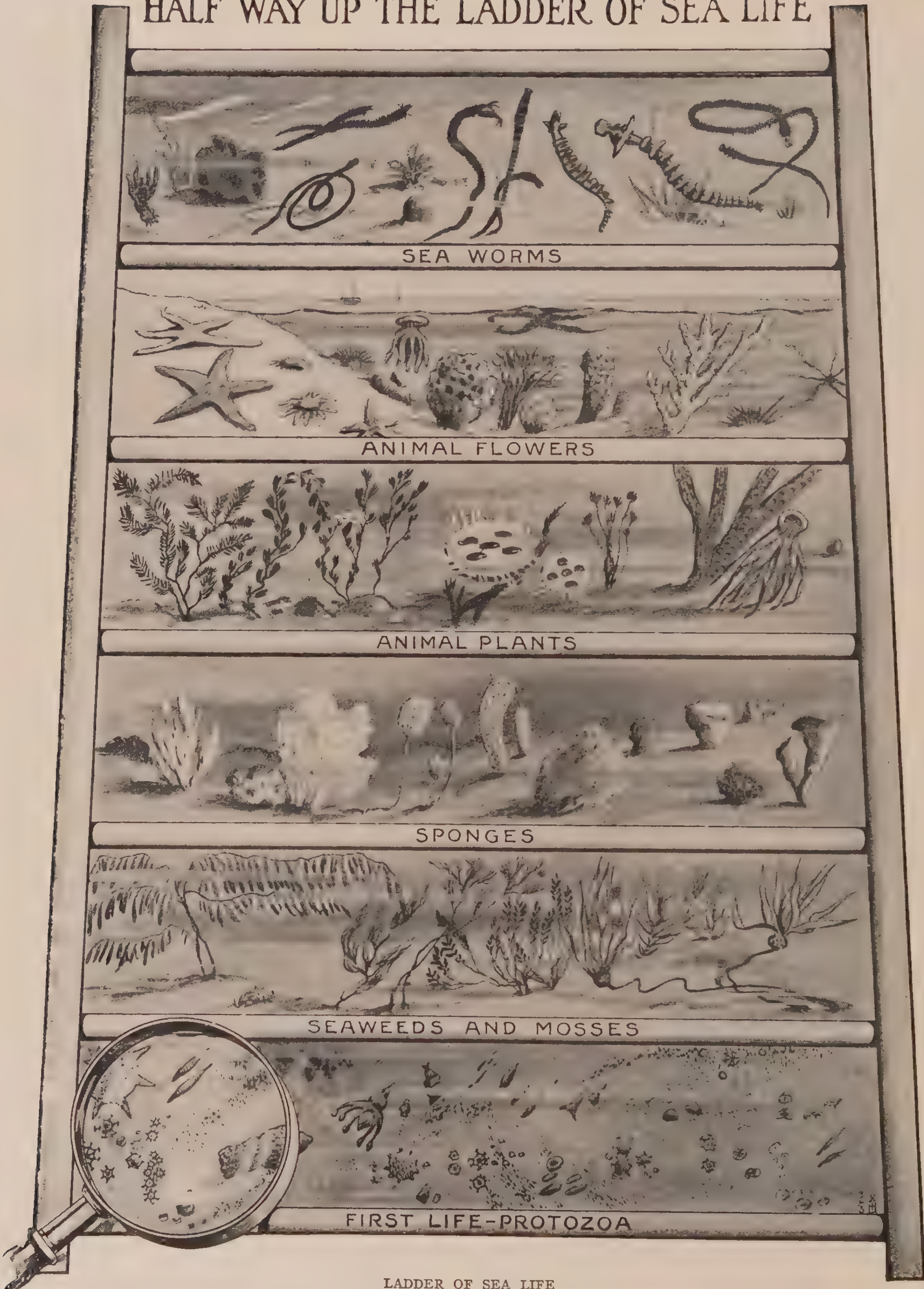
One of the greatest of English scientists, Professor Huxley, made a piece of chalk the subject of a lecture so wonderful that everybody who loves the world about him should read it in "Lay Sermons," if he has not already done so.

Professor Huxley told his listeners how, by powdering up a particle of chalk, and looking at it with a microscope, you could discover a whole new, ages-old world, of which you had known nothing before. This powdered-up chalk is nothing else than myriads of the skeletons that ages ago covered the bodies of the Protozoa, called *Foraminiferæ*, meaning "pore-bearing," so called from the tiny holes in the shells through which the living creature puts out his "false" feet to enwrap his living food.

WHAT MARBLE IS MADE OF

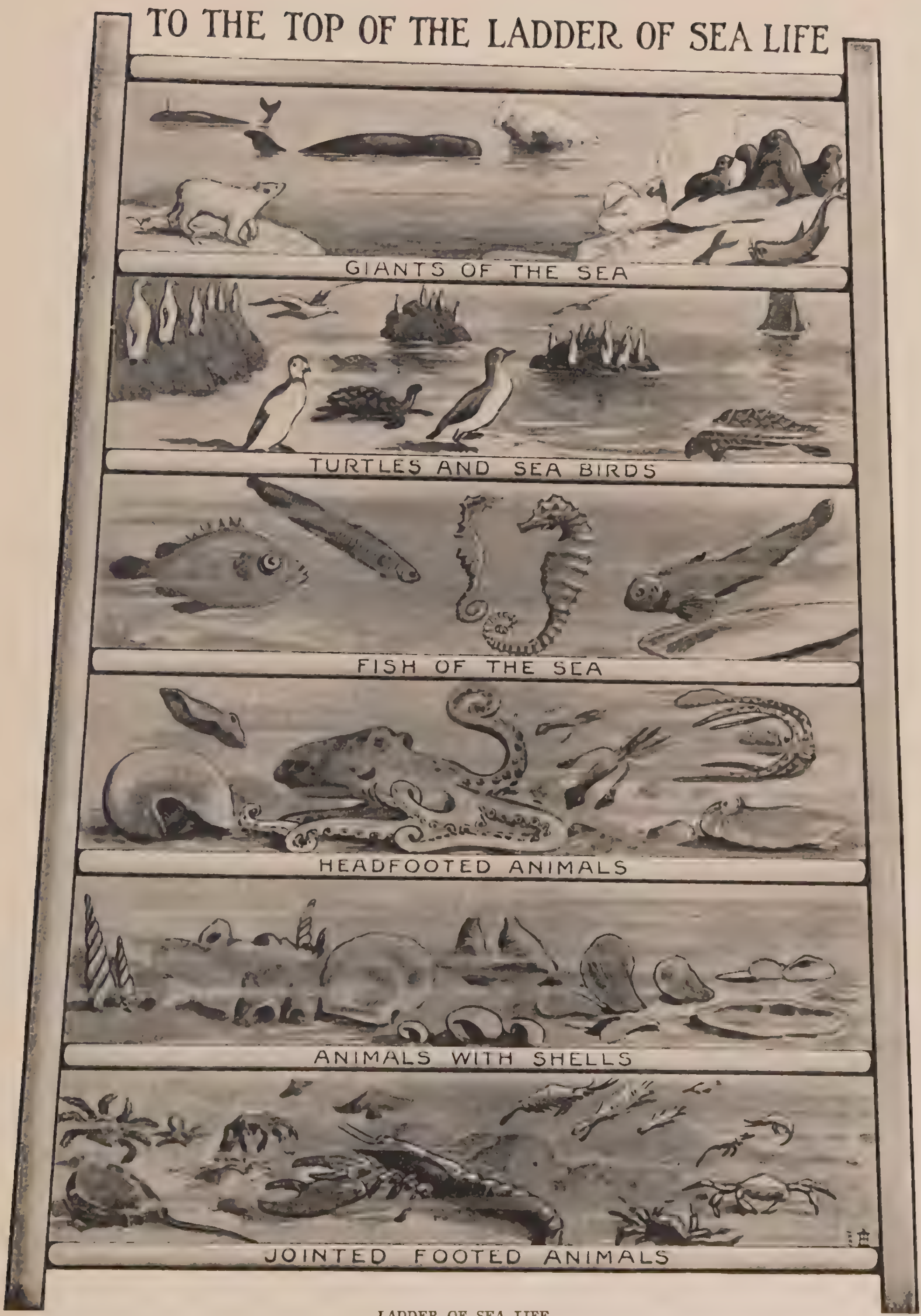
Now, will you not feel better acquainted with *Foraminiferæ* when you learn that not only is chalk made up of these ancient shells, but that the bottom of the ocean depths is covered with them, that the pyramids of Egypt are made

HALF WAY UP THE LADDER OF SEA LIFE



LADDER OF SEA LIFE

Step by step the sea creatures climb the ladder of life. Above the one-celled Protozoa, seen only through a magnifying glass, are the cell colonies of seaweeds and sponges. The next group are on the borderland between animals and plants. Then come starfish, jellyfish, and sea anemone, and the more highly organized sea worms, with rignts and lefts.



LADDER OF SEA LIFE

Now come crabs, lobsters, and shrimps, shell dwellers like the oyster and the clam, an odd group with the octopus and pearly nautilus, and at the top four classes of animals with backbones, the great army of fish, turtles and tortoises, birds of the sea, and the whale, dolphin, seal, and porpoise. Look for them in the story of each group.

of them, hardened together into marble; that the marble of our buildings is nothing else than these same lowest of Protozoans, the pore-bearers? Each tiny animal furnished its particle of the mass; race after race left its minute shells behind it; through ages the work went on to cover the ocean floor, to form the chalk cliffs that gave England, in the days of Cæsar, the name of Alba (white), to make the marble quarries that furnish that most beautiful city of Paris with its building material.

Side by side with these simplest of life's animal children, the Protozoans, there are forms of sea life — the seaweeds and sea mosses — which match them perfectly in grade and are much better known to people in general. These are in the vegetable instead of the animal world. Before you go on up the ladder of animal life, it will help you to become acquainted with their forms and ways.

HOW SEA FAMILIES ARE FOUND OUT

As you read this story of sea life, which seems to run along so smoothly, you must remember that it is a story which could not have been told fifty, thirty, twenty, or, in some parts, even ten years ago. It is as if all the members of a family, hundreds and thousands of them, had scattered to all parts of the world — and then someone went to work to find them out. Some of them would look alike; others might seem to look alike, but would prove not to belong to that family at all; and still others would be almost impossible to trace.

So some of the sea families were worked out on a plan which was not right until scientists could take their microscopes and study the tiny cells of which they are made up, and divide them in companies which were right, not because they looked alike on the outside only, but because they were made the same way. Watch the families as you go on, and see how very large and very small creatures prove to be of the same branch, and how each one has its own special mark by which we know it.

The order in which the story is told is the order in which creation climbs the ladder of life. We might study it on land, beginning with the simplest one-celled land creatures and working up to man. Here we are doing it in the sea, where some of the most beautiful and interesting lower forms of life are found. The story of life is the most wonderful story in the world. It begins in the drop of water, which seems to us lifeless, but has myriads of living creatures in it. It opens with one single cell. Watch, as you read of the sea families, to see how each gains something over the last, and climbs a little higher on the ladder of life, until every great class of the animal kingdom has its representatives in the ocean. Because in each class the forms are very simple, there is no place to study the beginnings of life like the sea.

A SINGULAR SEA PLANT

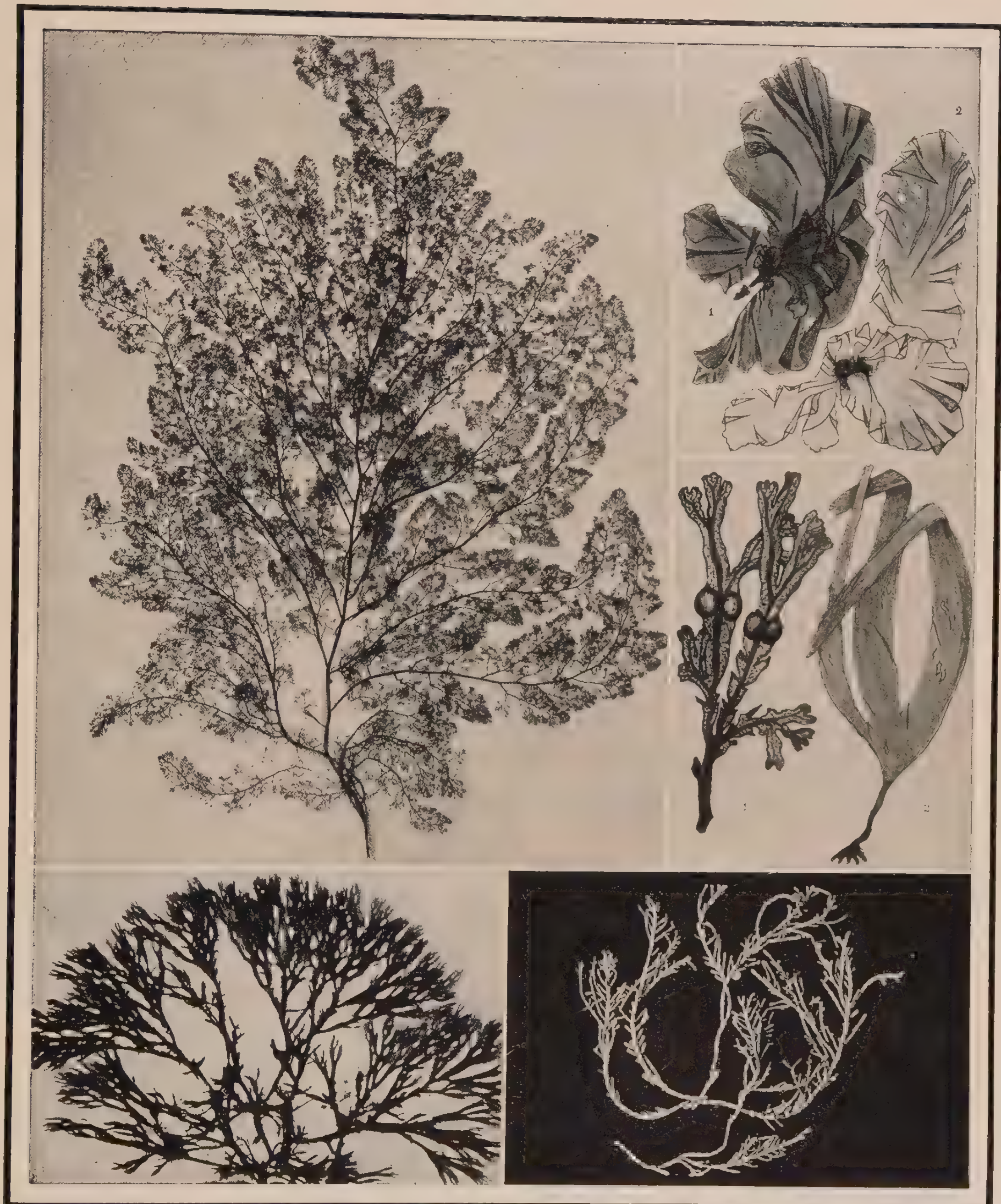
ALGÆ

WHAT kind of plant must it be that has neither leaves, stems, roots, nor flowers? Yet there are plants of which this is true, and if they were counted they might outnumber many better known kinds. Such of these as have their life in water and are wholly fed by it are called *algæ*. They are commonly known as "seaweeds," but algæ is their real name and it is pretty enough to be kept.

Algæ consist of cells, and it is the way these cells have of arranging themselves and of acting together which makes their story of such wonderful interest even to those who may never actually see them. Besides, these humble little plants are of the greatest help in teaching things about life itself, such things as are not so plainly seen in higher plant forms. Do not forget, however, that while companies of the algæ reach gigantic size, they are made up of minute cells, and that when you study them you are wearing, or someone is wearing for you, the strongest of spectacles, the microscope.

THE GIVE AND TAKE OF LIFE

As water covers two thirds of the whole surface of the earth, there is plenty of room for the mighty hosts of algæ needed to keep alive the tremendous number of sea creatures large and small which depend on them for food. Water has in it many elements that animals need, but they cannot take these directly from the water.



SEA MOSSES AND SEAWEEDS

Try to imagine these sea mosses in their original colors, red, purple, soft green, brown, and yellowish, floating on the water. The large one is a branching red variety; at its right are the green and purple lavers, their fronds broad and flat; the bladder-wrack with its oval bladders which are filled with air and explode with a noise if you step on them. Below to the left is the tree-like red Delesseria, and to the right the deep purple coralline alga, which has the power of sucking out lime from sea water, as do the corals.

Vegetable life feeds on these very elements, this inorganic matter, which water contains.

The word "inorganic," which you will constantly meet, means "without organs," and expresses the difference between a mineral or a stone or crystal, and a fish or dog or man. Your heart and lungs are "organs" of your body; the stone has nothing but its various chemical elements and is "inorganic." By the way, you should never pass a new or strange word without finding out its meaning, or, if you have not a dictionary at hand, marking the word to look up at the first chance. That is a delightful study, when you once begin it, for words often contain both pictures and history.

Plants like algæ take this inorganic matter from water for their food, and change it to material which animal life needs, such as starch, albumen, and sugar. Then the creatures of the sea feed on the plants and gain their required nourishment, so that the algæ are a needed chain in the whole life process which under many forms is really one. The same thing takes place on land with plants and animals, and keeps up what is called the "balance of life." By breathing in for their life what animals breathe out (carbonic acid), and breathing out oxygen which the animals must breathe in, plants take their part in a give-and-take process which has in it a lesson for human beings, who are too slow in learning to keep up such an interchange with their fellow beings.

WHERE TO LOOK FOR ALGÆ

Seaweeds are studied best in two groupings. First, as to geography, there are kinds which are found along the Atlantic shores from polar regions as far south as Cape Cod; others from Cape Cod to Cape Hatteras, from Hatteras to Florida; and truly tropical ones from there to Florida Keys and the Gulf of Mexico. On the Pacific coast the divisions are also well marked. Another way to group them is to begin at the line of high water, and study first the seaweeds to be sought between lowest and highest tide-marks, then those between lowest tide and fifteen fathoms (ninety feet) depth, and lastly those between fifteen fathoms and fifty.

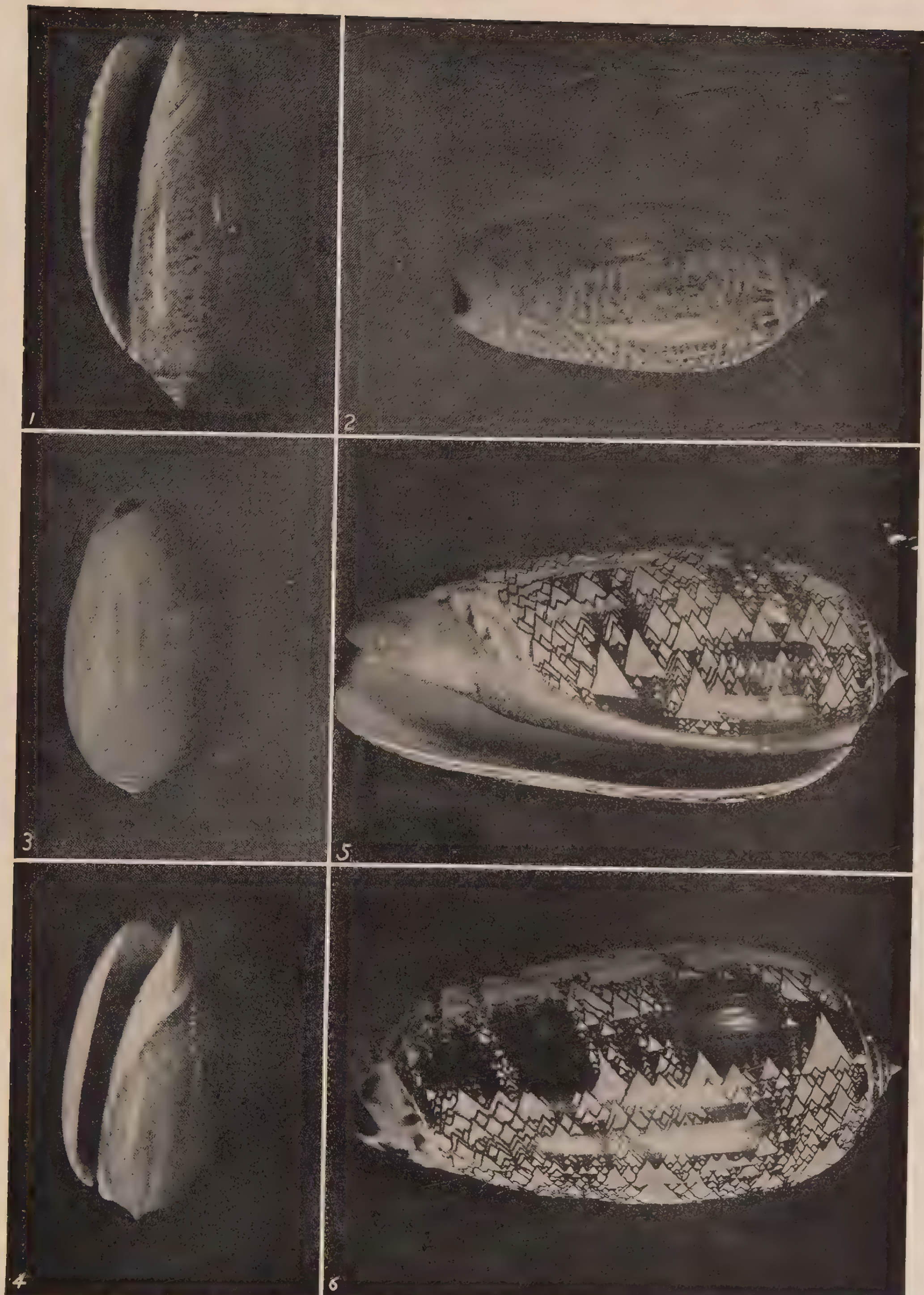
Taking the second grouping: the first condition is of plants exposed every twenty-four hours in turn to sun and air, and to water. To be alternately dried and wet every day does not harm them, because of the presence of a sticky substance like gelatine or glue, which these particular algæ cells produce as bees produce wax. Irish moss is a well-known seaweed which peasant people gather from rock-ribbed coasts. In fine bleached form it makes an excellent blanc mange much valued in sickness. In coarser form it is a food for cattle. All these rockweeds which are so easily obtained from the edges of the sea are useful, either as fertilizers for the land, or when burned and ground in great quantities to furnish soda, iodine, and bromine.

The beautiful red algæ, of which there are very many kinds, are an example of the second class, found at the lowest tide and a little way out to sea. The Red Sea is so named from the color the seaweed colony gives to it. These are the sea mosses which branch out in graceful shapes of every kind.

In the third class are the so-called coralline plants, though they are not corals. In place of the gelatine or glue of the high and low tide seaweeds, these have a secretion of lime which gives them more stable form. These deep-sea algæ help to make great deposits at the sea bottom. It is first an ooze in which creatures live, but it hardens in time into solid rock. The city of Richmond, Virginia, is built upon such a fossil bed, from twenty-five to eighty feet thick, which was part of a sometime teeming city of quite another kind of life from that which it now supports.

While each tiny alga cell is soft and nearly transparent, such a mass of it as makes a beautiful form and is named a sea moss may have the toughest kind of texture and be really highly colored. Seaweeds vary from being as thin as the lightest paper to being tough and leathery and almost as hard as wood. A great many are jellylike in their texture, hardly holding to form at all when out of water.

In color, seaweeds are often very striking. Whatever hue can be made by combining the three main colors — red, green, and brown — algæ seem to have either found out or stumbled upon in their beautiful soft tints.



From "Shell Book," Copyright, Doubleday, Page & Co.

OLIVE SHELLS

One of the most interesting employments at the seashore is the mounting of seaweeds on drawing paper. This is a simple process, owing to the gelatine in them; and it makes often a dainty picture, besides showing the marvelous variety in form which different species display. This runs from the finest tracery of mere threads to flat masses called *fronds* — tubelike lengths which, while they do not perform the work of real stems, help to fasten the seaweed at one end either to a rock surface or to some plant, leaving the other parts free to wave or float in the water. A most curious little contrivance is found in some of the commonest seaweeds, by which air bladders are formed a little way apart in these fronds. It is partly by them that the plants float. When dried these beadlike balls explode with a great sound if stepped upon.

A SEA NAMED FOR ITS ALGÆ

Lying between Cape Verde and the Canary Islands is a section of ocean which presents, as a ship sails into it, the appearance of a waving prairie reaching farther than the eye can reach, covered with a yellowish brown vegetation, as tall grasses wave over true prairies. Columbus was the first to report upon this great expanse of brown sea, as large as the continent of Europe. The name was given to it from its plant, *sargasso*, a form of gulfweed, and it is always known as the Sargasso Sea. The sailors took fright at its marvelous appearance, as day after day they sailed in it. To overcome the fear of dangerous shoals Columbus tried to sound it, but found its depth to be greater than his line of two hundred feet could fathom. The sargasso are roving plants, not fastened to any spot permanently. Remember, when you read of stems in seaweeds, that the stem does not carry nourishment all along its line as true plant stems do, but only anchors the plant to its place. The food of the sea plant is taken in through its fronds.

SPONGES

WHY is it that, though long use will end in tearing a sponge to pieces, the pieces never wear out? If you take the tiniest particle you can pull off of a good soft sponge and put it under a lens, you will find it to be made up of an interlacing network of fibers of a material that in coarser sorts is much like the horn of our finger-nails, in finer sorts like the best silk of the silkworm. How long would spun finger-nails wear? A true answer would be, as long as a high-class bath sponge.

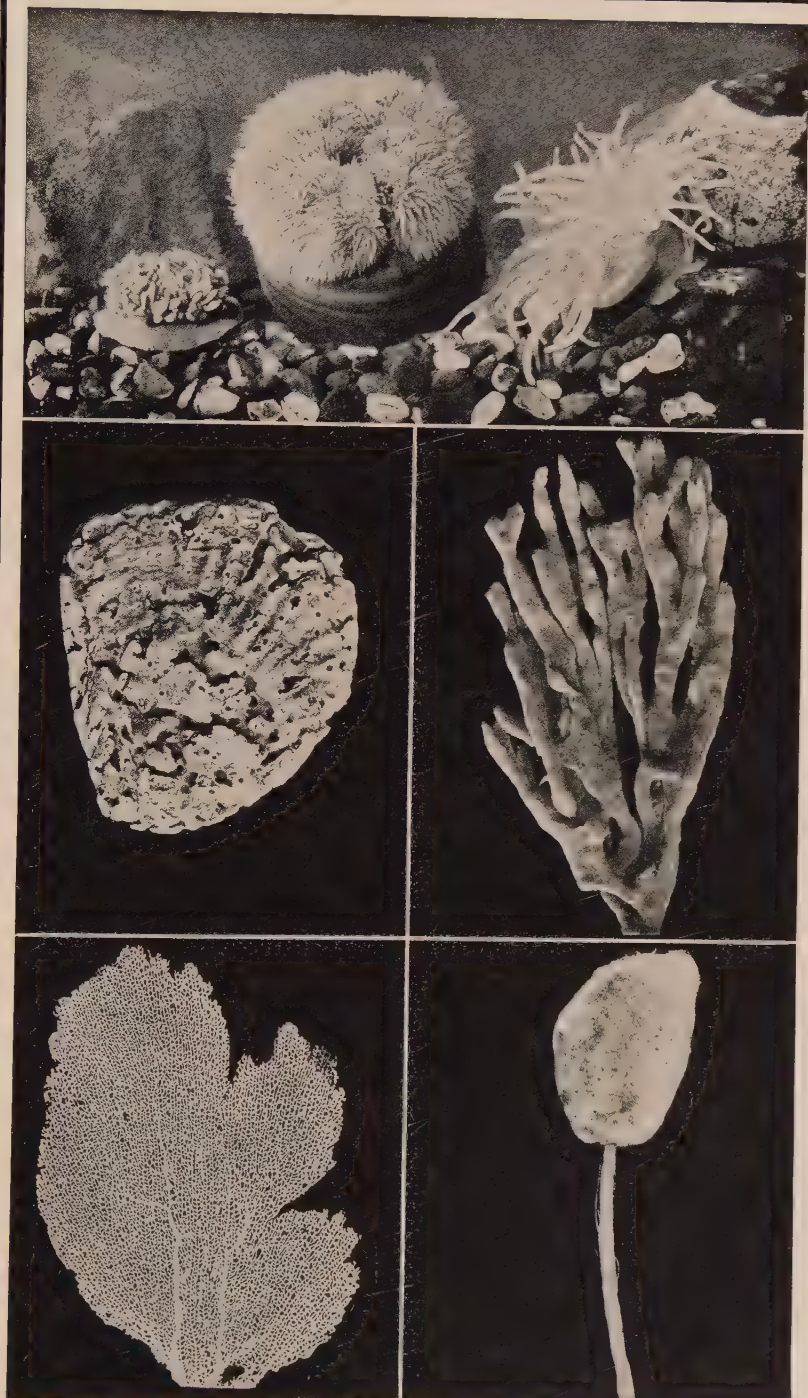
Next, why does a bath sponge never get "sour," like a face-cloth? Because this horny fiber is so smooth that it allows no lodgment for any of the soapy or other particles that so certainly catch on to the myriad fibers of cotton or linen. It cannot itself decay, like cloth, being made of this horny material, called "chitin," which with almost equal success resists heat, cold, moisture, or dryness.

Though you probably long ago learned that sponges come from the Indian Ocean, the Red Sea, the coast of Florida, the Gulf of Mexico, and the Mediterranean, and are obtained by diving, how much do you know of their nature, whether they are relatives of the rock to which they are fastened, or of the seaweeds among which they grow? Some are hollowed out like a cup, some branched like a shrub, others spread out like a fan and are of every color, from brilliant orange to dull brown.

If you judged from an assortment of sponges in their natural home in the Gulf of Mexico, where they top some rock, hide in some cave, or hang from some ledge, you would easily class them with the seaweeds. But you would be wrong, and wrong with all the world up to the time scientists were able to study the sponge with the microscope.

EVERY SPONGE A COLONY

Since that time it has been found out that the sponge is made up of a great host of cells that are able to live together in a group by reason of certain sets of cells doing certain parts of the housekeeping and trusting other sets to do other parts. It is a wonderful example of the first coöperative housekeeping, after a fashion set some scores of millions of years ago. It took the microscope to suggest how well it might work among humans. And though it has been only a half-success among human beings, it has been "without a hitch" among sponges since the beginning of sponge-time.



SEA ANEMONE, CORAL, AND SPONGES

Above: Beadlet, Dahlia, and Snake-lock Anemones; below: a shell attacked by Boring Sponge, a Branching Sponge, a Sea-fan or coral, and a Glass Rope Sponge.

To understand sponge development, it is necessary to start with a sponge-germ dropped from a colony. The sponge starts like one of the Infusoria, as a single cell, only that when the cell divides, the two parts stay together instead of separating. These two divide and become four; the four, eight; eight, sixteen, thirty-two, and so on, until the bunch of cells withdraws to an

A SPONGE FROM THE SEA BOTTOM

outside crust, leaving a hollow in the center, like a hollow rubber ball. These cells are all provided with lashes (cilia) which wave about and carry the developing sponge through the water. After a time one side of this hollow rubber ball stage bends in so as to form a double-wall cup, and the sponge settles down. Meanwhile the sponge has lengthened and narrowed until it is about the shape of a pussy-willow, a quarter of an inch long, with a small opening at its free end and fastened to a rock at its closed end, ready to finish the fancy interior details of its house at its leisure.

Now the cilia, which have been at work paddling the sponge along, can begin their life-work of gathering food, and so is built up the supporting framework of horny chitin, of lime spikes, called "spicules," or of flint spicules.

HOW SPONGES PROTECT THEMSELVES

One of the strangest things you can ever see awaits you when you boil out a bit of one of the most primitive of the "calcareous" (lime spicule) sponges to see the marvelous framework built up, at once to support the slimy body of loose cells of which its owner is made and to make itself a disagreeable bite for its enemies. The sea is alive with animal life that "just loves" sponges without spikes. But sponges with spicules — points and darts and tridents, barbed and hooked and double-spiked — who wants a second mouthful? "Excuse *me*," says water flea. "Enough this time," says sea worm. "I never could eat spun finger-nails without a pain," says fairy shrimp.

So Nature has made a great success of her second trial of building up the animal kingdom; for until man, with hooks and hands, drags the sponges from their ocean homes, these humble denizens of the deep can hold their own against any enemy that would like a taste of their soft flesh.

Man has never been able to invent anything to take the place of the genuine bath sponge. Since the world has become certain that the "rubber sponge" won't do, sponge-growers have begun to see that they can help Nature along in her work. So, taking advantage of the fact that a piece of sponge torn from the living colony will survive and increase, the sponge-growers tried placing sponge-clippings on spindles set into a cement block and lowering them on to the ocean bottom. There they remain a year or two and increase in size at the rate of five times the cutting every six months.

Then the sponge culturists experimented by suspending the cuttings along wire attached to uprights. But finding that the sponges sagged and made large central holes, they have greatly improved by using lead wire, with a copper core for each cutting.

Now that it is possible to grow the sponges away from the great depths that necessitate the expensive submarine armor, it is to be hoped that Florida sponge culture will supply this great and permanent demand for the horny sponge's skeletons.

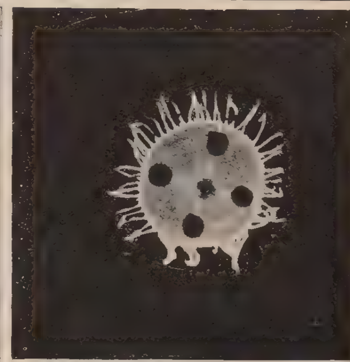
Gradually the primitive method of pushing off the sponges in water of wading depth by the toes; the method so long in use in Mediterranean waters of naked diving to a depth of fifty feet and remaining under as long a time as possible; and this later expensive method of the diving dress, where the diver goes to a depth of one hundred and fifty feet and stays for two hours — all these will be old ways when sponges are grown in sufficient abundance to supply the world at a depth that allows the gathering of those of known size by poles, from the side of a boat, assisted by a glass-bottomed bucket.

Courtesy American Museum of Natural History

ANIMALS OF THE WHARF PILES

THE OSTRICH PLUME HYDROID

THE "ROUND-TOED" CELLS OF THE SEA MAT



A TINY HYDROID JELLYFISH

ANIMAL PLANTS, OR PLANTLIKE ANIMALS

LOOKING much more like plants than some of the sea plants themselves are the Hydrozoa, in which we cross the long-disputed boundaries between animals and plants. The unit of this life is a simple polyp, hardly higher than the Protozoa, but growing together in communities of wonderful beauty and symmetry.

A Hydrozoan, like the sea fir, is a colony of thousands of these very minute polyps, in which each saclike body, while hungrily feeding itself, is helping to feed the whole. Joined to the common life by what we may call its foot, each single one can act independently as far as its own life goes. It is as if the whole community had what the name Hydrozoa implies, a hundred heads. The word means Hydra-like animals, and in legend you may find it in the old Greek story of Hydra with the hundred dreadful heads.

LIFE AROUND A CENTER

Each little head, a unit of life, appearing at the top of its little cup almost like an opening flower, shows under the microscope a circle of slender waving arms, or tentacles, which crown the polyps and surround the mouth. These waving tentacles every now and then seize upon specks of things floating in the water, and with a kind of lassolike movement bring them back to the open mouth. Or some tiny microscopic creature, wriggling through the water on its own account, brushes against one of the flowerlike heads and anon it is held fast by the lasso. It is seen to give a few convulsive struggles, but is soon stilled and quickly carried back by the long lasso. Why might it not have broken away from those soft, clinging threads?

LASSO THROWERS

The polyp tentacles are not so simple and harmless as they appear. It is not wholly a matter of strength. Each cell has coiled within it a fine, long, hollow thread, with several sharp barbs at its base. At the top of the cell is a hair trigger which keeps the coiled thread in place, and so sensitive is it that the slightest brush causes it to respond and release the coil. Is not this lasso throwing? The unfortunate victim by its struggles touches more of these cells, and more coils uncurl and dart out to grasp their prey. And as an added peril they are "stinging cells" as well, which touch the poor thing and poison it. This active quest for food shows the advance of the polyp over the seaweed. The actual mouth leads to the stomach, which communicates with the hollow tube that runs through the whole colony, supplying digested food for the common need in true coöperative fashion. Nature here supplies a fine illustration of economy in food supply.

THE POLYP'S CHILDREN AND GRANDCHILDREN

The single polyps in each of the various tribes — sea firs, sea plumes, and moss animals — are so alike that they cannot be told apart. But on

THE TUBE OF THE SAND MASON (LEFT). THE SEA MOUSE (RIGHT)

some of them, at certain times of year, buds appear here and there. These are larger than the polyp cups and shaped like closed windows, and are the homes of the polyp's children. These buds being quite transparent, the children inside them can be watched. They remain mere specks of things shaped like saucers until fully grown, when on some fine day a bud bursts and out they come, not nice sea fir polyp children, but little saucer or umbrella-like jellyfishes! And these tiny jellyfishes never become larger, like the true jellyfish, nor yet do they become sea firs. But in due course of time, in which they have led a free, roving life, swimming by opening and shutting their umbrella bodies and capturing their food by waving the tentacles which fringe their edges, these free creatures, unlike the parent polyp, produce eggs, and from these come strange little oblong things, called *planulas*, that are no more like their parents than the jellylike parents were like their parent sea firs. These planulas are clothed with lashing hairs and so are able to swim freely, but after a while each settles down, firmly fixing one end to some suitable resting-place, and in a short space of time there comes at the free end a tiny mouth, a circle of tentacles around it which can throw lassoes; and lo, the little being grows to be the exact image of the polyp from which its parent jellyfish came!

This is one of the most curious and wonderful processes in Nature. First, we have our pretty colony of feathery forms that can grow only by budding like a plant. From the bud spring jellyfish children, and from their eggs come planulas, the grandchildren of the feathery sea firs, which grow up into sea firs and begin the curious story over again.

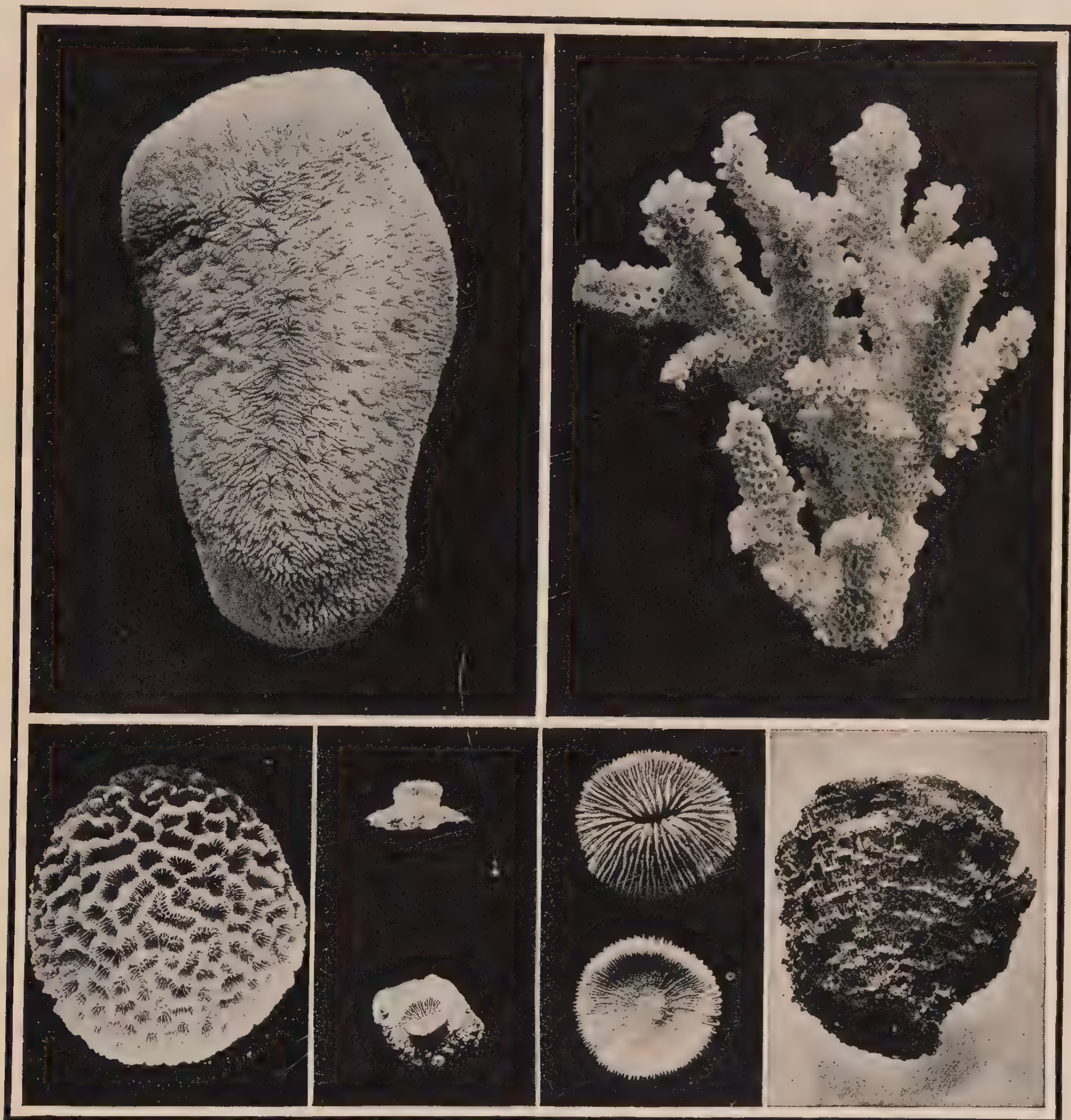
THE GREAT JELLYFISHES

The rhythmic motion of the umbrella-shaped bodies of the great jellyfishes as they glide through the water in delicate ghostly forms is a sight to remember. At night many of them are lighted up by a strange glow of phosphorescence. Some grow to a great size, but are fragile things, and they live only from springtime to the coming of the first autumn gales. Planulas, or little children of jellyfishes, are safely anchored in the quieter, shallower waters, ready when spring returns to send forth a new brood. From a single little planula, by a division which is quite natural to it, may come several hundred jellyfishes. Is it not wonderful how many resources life has for maintaining itself?

ANIMAL FLOWERS

WATCHING A POOL GARDEN

THE pool gardens are the most delightful parts of the seashore. Each is a little world, a hollow in the rock, where fine and beautiful seaweeds grow, quaint creatures live, and all sorts of unexpected treasures are to be found. Some of these pools are so deep that you can wade about in them, and the water is so clear that the happy little inhabitants can be watched as they dart in and out of the forests



CORALS OF MANY SHAPES AND KINDS

of seaweed. When the tide rolls in the pools are a part of the sea, but when it draws out they are left full. So the water is kept clear, and no one knows what newcomer may happen to stray in from the great sea.

THE SEA ANEMONE

The sea is full of "make believes," animals that look like ribbons, plants, and weeds. Among these deceivers are the anemones of many different kinds, each with two names, with which we have little to do here, but also for the most part with a common name like *dahlia*, *daisy*, *cloak*, and *sand*, used with the family name anemone (pronounced an-em'-o-ne). When the sea rolls over them they lift their pretty bright heads, rising on a sturdy trunk to four or five inches in height. Circles of dainty frills uncurl, white, cream, or salmon

pink, around the circular top in which is the mouth. Below this is the open sac in which the creature digests its food. The tentacles around the mouth are sometimes like little fat fingers, sometimes like whiplashes or fine and featherlike flower petals. You would not think such pretty things could be harmful. A tiny baby fish knows better when they curl about it, roll it to the center and before even such an active little body can get away, down it goes into the mouth, stung by these nettlelike arms.

CORALS AND THEIR ISLANDS

It has been said that some of the polyps secrete lime in place of the tough gelatine. Among these are the true coral polyps, which when seen alive are fully as varied and interesting in their forms as the anemones.

Feeble as a single coral builder (polyp) is, with all its lasso cells, united with enough fellows of his own sort, he has built masses of limestone which are the foundation of islands, extending over a space five thousand miles long and fifteen hundred miles wide. The South Sea Islands, called Polynesia, are most of them coral islands. A coral island is encircled by a reef, or ring, of coral. Waves dash without ceasing against the reef, and a long line of foam sparkles in the sun. No rampart of mere rock could resist in this manner the action of the waves. It would be swept away in time and destroyed. Yet age after age the coral reef holds its place, a living barrier. Millions of little architects are always at work, or at hand to repair an injury. Streams of fresh water that keep flowing from the island itself kill the first line of polyps and prevent the formation of a reef in front of them. The foundation of these islands may be of volcanic origin, and not at all the work of the coral polyps, which cannot live at great depths. Their work must have been begun where some portion of rock was covered only by a slight depth of water. Generations after generations of polyps pass away, and still the work goes on. It must stop, however, as soon as it reaches the surface, for the polyps cannot live out of the sea. At first there was only a rough ledge or platform, covered in patches with coral rock. As the tide ebbed and flowed upon it, seaweeds, shells, and sand were cast up which in time formed a soil on which seeds, no one knows from where, took root and so shrubs and trees at last appeared. Finally people arrived to make the island their home.

SEA WORMS

ANIMALS WITH RIGHTS AND LEFTS

THE true student of nature, or biologist, finds worms to be among the most interesting of the lower orders of life. Some of the sea worms are even beautiful in form and coloring; and they are the first examples of several parts and ways which become the natural rule in higher forms. They are, for instance, the first creatures to carry a certain part of the body forward by the help of the other parts; the originators, we might say, of "going ahead." They are also the first to have parts that are alike set opposite each other along a line. This is called "bilateral symmetry." Consider what a great number of higher creatures have right and left sides matching each other, and think if this rise in life is not enough of an achievement to entitle the pioneers in such a plan to our respect.

There are four distinct classes, easily recalled as flat, thread, wheel, and ringed worm. Names used by the biologist and naturalist are given with the illustrations in order to help you follow up the knowledge which you gain here, in scientific books, which are easy enough to con-

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HUNTING FOR SEASHORE TREASURE

What will they probably find? Seaweeds washed ashore at high tide, shells, possibly with living creatures in them, tiny fiddler crabs, starfish, and sea anemone in the pools, clams if they dig for them, and sea worms of every species.

sult when you know the name of that for which you are looking.

HOW EACH GROUP GAINS ON THE ONE BEFORE

It might be well to review the groups that we have noted thus far, to see the gradual rise in scale of being. The sponges gained over the Foraminifera and other Protozoa by coöperative life and protecting skeletons; the lasso-throwing hydroids had their poisoned weapons; the echinoderms, their prickly skins, tube feet, and

This "White Cat" Worm is nearly a foot long.

stony casing. The mark of the sea worms is that they are better formed for speed, and have nerve cells and fibers. There was a beginning of nerve action, and so of sense life, in lower forms, but in worms it rises to a real power which can be directed for what the creature wishes to do.

JOINTED BODIES

The lugworms, which the fishermen dig for bait, are of dark brownish green color and measure from five to ten inches in length. If you were to look at one of them you would see a series of joints or *segments*. At the head end, six of these carry a double row of fine bristles. Then come twelve or thirteen segments each bearing *gill tufts* and bristle-clad feet. The gill tufts are the worm's breathing apparatus. They are yellowish red, and look through the microscope like graceful boughs of a miniature shrub.

Because the lugworm's head is made in parts or segments, he can lengthen and shorten it like a telescope, making it either cone shaped or flat at will. He can draw it in and make it a boring tool which will open up a passage through the sand, and then enlarge it by widening till the delicate gill tufts can be drawn through behind it without being injured. A

This extraordinary-looking worm becomes beautifully phosphorescent at night, and is called the Vari-footed Worm.

great deal of sand is swallowed in the process, and when the food that is taken with it has been digested the sand is thrown out, making curious little mounds. If you know the ways of the interesting land cousin of these worms, you will recall how soil is made loose and fertile by passing through earthworm bodies in the same way. The lugworm is like a mole in

avoiding the light. It tunnels to eight or nine inches for its home. If you find one in the sand, it will make an interesting study.

FLATWORMS, WITH A SHARP TONGUE

Coiled under a flat stone on a sandy shore you will often come upon a worm which looks like a ribbon wound up in a knot. This is one of the flatworms, or ribbon worms, which are of all lengths, from less than one inch to several feet. Placed in water the worm will uncoil. The blunt end is its head, and the mouth is on the under side of its body. From an opening above the mouth a fine thread can be shot out and drawn in with much force. This proboscis, or tongue, has often a sharp point and smaller barbs, so that it is quite a formidable weapon. Flatworms have upper and under parts, and a front and a back. They are supposed also to have eyes, and even some sort of organs for hearing.

These worms are all greedy creatures, devouring anything living or dead which comes in their way. They are cannibals, too, and frequently devour each other. They have also the power of re-growing a lost part, though while the head part will grow a new tail the other part lives awhile, but does not gain a new head. One large nemertine, however, seems to have a habit of breaking up into short lengths if irritated, and each length grows a head and tail and becomes a complete worm. A snapped-off proboscis is quickly replaced. Spiny parts of other creatures which the nemertines swallow are pushed out through the soft flesh without seeming to cause injury, as the parts quickly heal, showing no sign of the wound.

ROUND WORMS

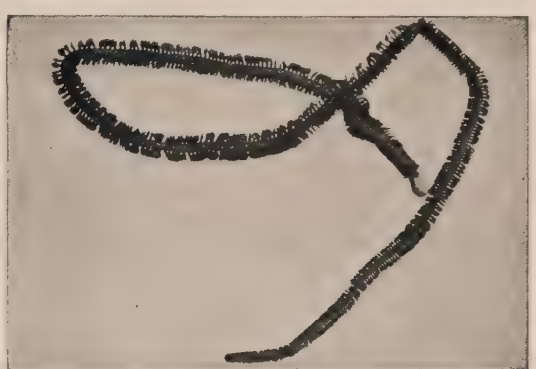
The round worms are mostly *parasitic*, by which is meant living not by honest work, but fastening upon other creatures and drawing their food from them. The common tick is an example of a parasite. You know how, if fastened upon the flesh of an animal, it will draw the life fluid till it is almost ready to burst.

TUBE BUILDERS AT WORK

The sand mason is an example of the numerous worms that live in little tubes or towers which they have built for themselves and into which they can retreat at the first sign of dan-

THE "RED CAT" WORM

A shore species often used by fishermen for bait.



THE PADDLE WORM

It propels itself by its many legs with a snaky movement.

THE LUGWORM

It is from five to ten inches long, and tunnels into the sand for its home.

ger. Around the mouth of the builder are a multitude of long, threadlike feelers, or tentacles, each having a groove running its entire length. These grooves are capable of being extended and are used by the worm in collecting the material for its tube. A piece of shell or grain of sand travels along the groove the whole length of the tentacle to the mouth. There it is moistened with some sort of secretion, pushed

SEA URCHINS

out and put in place on the edge of the tube. Bit by bit, grain by grain, the sand mason builds up its cell, decorating it with gleaming bits of shell.

The highest class of worms are the ringed, or segment, worms. They are called *annelida*, which means ringed. Each ring has a separate set of organs. Some annelids have scales; some bristles; others have tentacles around the head and inclose themselves in tubes. The eye and ear are more highly developed in the annelids, and their nervous system has distinct centers, or *ganglia*, the work of higher powers. The aphrodite, sometimes called the sea mouse, is one of the most beautiful of worms. It is brightly iridescent, or rainbow-hued. The sea mouse lives below tidemark, but is found on the beach after storms.

PHOSPHORESCENCE

Many of the sea worms become beautifully phosphorescent at night, shining with a wonderful blue or greenish radiance, constantly changing and so bright that if one or two are placed in a small glass tank filled with sea water, it is possible to see by their light the figures on a watch and tell the time. Looking down into the sea on a dark, still night, and watching these writhing phosphorescent lights, reminds one of the vision of Coleridge's Ancient Mariner:

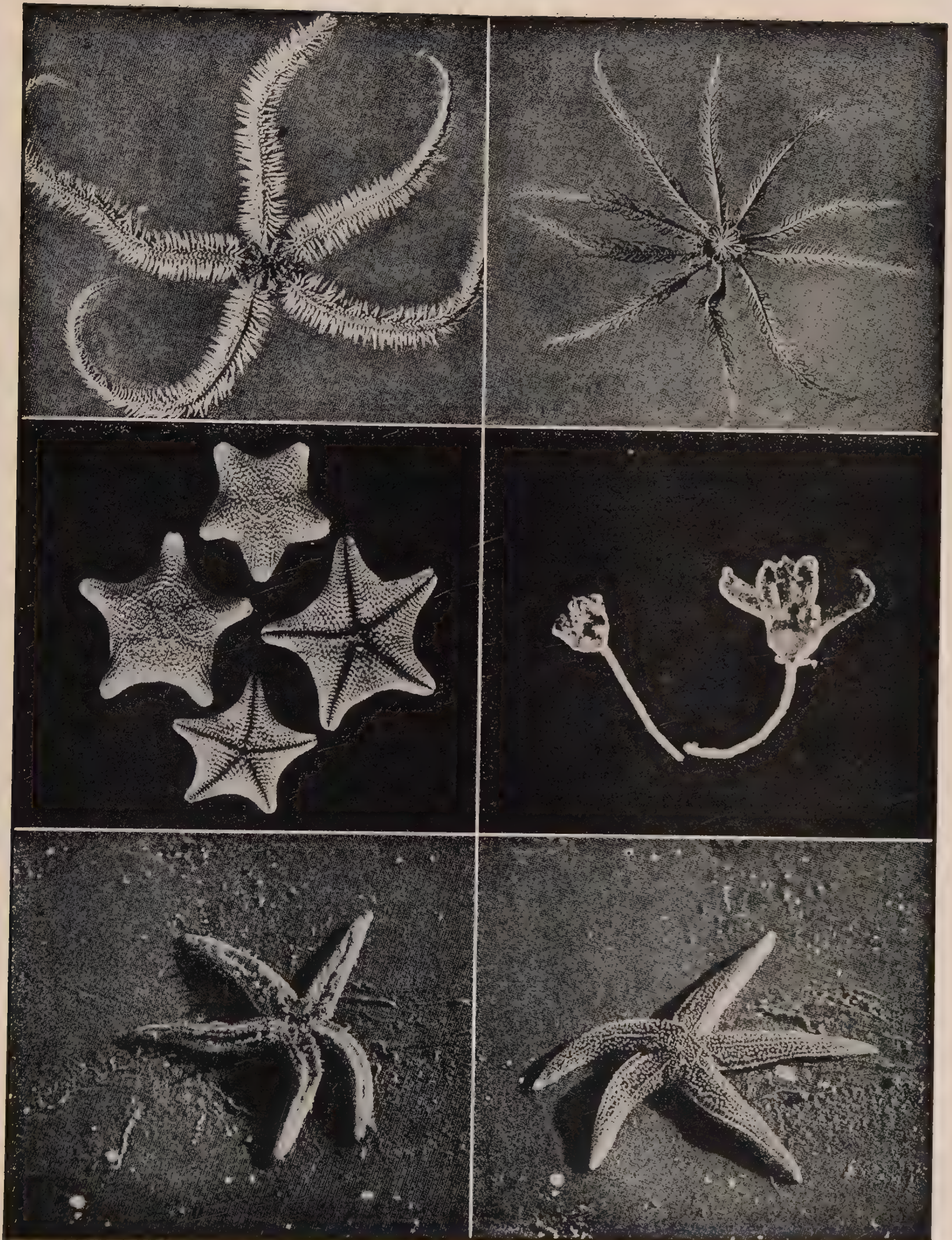
> "Beyond the shadow of the ship
> I watched the water snakes,
> They moved in tracks of shining white,
> And when they reared the elfish light
> Fell off in hoary flakes.
>
> "Within the shadow of the ship
> I watched their rich attire:
> Blue, glossy green, and velvet black
> They coiled and swam; and every track
> Was a flash of golden fire."

STARFISH AND THEIR COUSINS

IN starfishes a great advance is made beyond anything which is seen in the lower subdivisions. They are the highest of the radiates, creatures whose parts go out from a center. All the plantlike colonies, the small jellyfishes, the sea anemones, and the sea fans, are radiates.

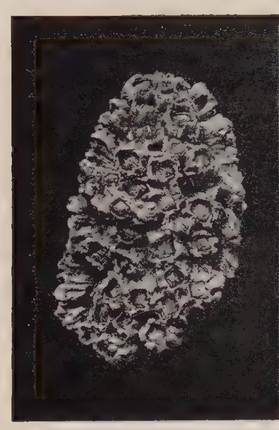
Starfishes belong to the Echinodermata, which is not a hard word when it is analyzed. It is from Greek words for "hedgehog" and "skin," and is given because the most striking thing about the creatures is the rough, spiny armor. There is quite a variety among echinoderms: the *crinoids*, or sea lilies, among the most common fossils, and different sorts of rayed starfish and brittle stars. The boxlike sea urchins and their distant relatives, the wormlike sea cucumbers, are the chief among them.

To understand the whole group of animals it will be well to become acquainted with the structure of one of them, and a starfish is a common form and is typical of all.



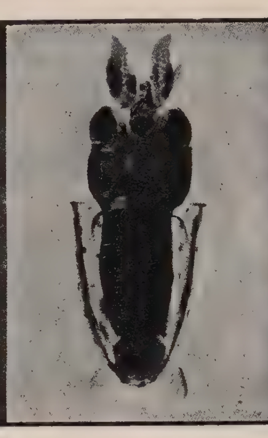
STARFISH, OUR FAMILIAR ACQUAINTANCES ON THE BEACH

Above to the left the Brittle Star, to the right the full-grown Feather Star, and below it the Baby Feather Star, with next it the four plump Cushion Stars. The lower line shows the under and upper surfaces of a Starfish.



BARNACLES ON SHELL

STALKED BARNACLES



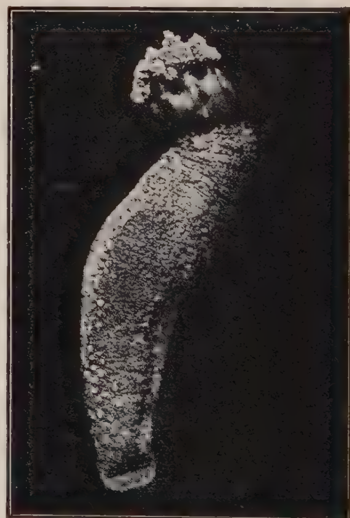
BABY SQUID

ATLANTIC SQUIDS

Almost everybody has seen starfishes, for when the life has gone out of them they can be kept as shells can. Seen as it lies upon the sand, its five arms stretched out, the starfish looks a helpless thing. You may turn it over and the most it will do will be to gather itself into a heap. It will not be very happy, but it will not try to get away till the tide rises. But you may put it in a little pool of water and learn how it crawls about. It seems to go in the direction of any one of its five arms, each of which has hollow tubes with suckers and an eye at the end. The skin is soft, and through it you can see the limy rods and plate which make its skeleton. Fleshy bumps all over the back have a skin so thin that the starfish breathes through them. Among the large spines of the back and along the under surface of the rays are tiny spines, each ending with a tinier pair of pincers. You see, the little creature has not only feet fitted for crawling along the floor of the sea or for climbing over rocks, and eyes to help it find its way about, but a most remarkable apparatus in the pincers with which among other things it keeps itself clean.

GROWING NEW LIMBS

It is now well known that starfishes, like many other creatures in Father Neptune's kingdom, have the wonderful power of growing new limbs to replace those that have been lost or injured. They are hungry, greedy creatures, and people who are watching their oyster beds know how skillfully starfishes can use their five arms in clasping an oyster so that they may eat the soft flesh within. The varieties of starfish are interesting, each for some new contrivance for the life the creature lives. The boxlike form of the sea urchin is a starfish with rays firmly joined around its soft, central body. An ugly-looking member of the family is called the sea cucumber. Lobster fishers have to watch against its getting into their lobster pots, in which case the lobster itself stays out.



THE SEA CUCUMBER

All these creatures begin life as odd little free swimmers, and go through many changes before they settle down. Twenty million eggs in a season sounds a big story. It tells, however, that other creatures of the sea depend upon them for food.

With the help you have from going thus far up the Nature line of more and more highly organized forms, the pictures of such species as you have not known will be more easily understood.

JOINTED-FOOTED ANIMALS

CRABS

IT is interesting to know that of the sixth subdivision of the creature world, by far the greater part live in the water. The crab is as well known as any of these *Crustacea*, or "insects of the sea." What we call the shell of a crab is not really a shell at all. That is, it is not like the shell of an oyster or a periwinkle or a whelk. In these creatures the shell and the animal grow together, and it is never thrown off all through their lives. But the shell of the crab does not grow at all. It is only a crust of lime on the outside of the skin, which will not even stretch. The only way in which a crab can grow is by throwing off its "shell" to make room for larger size.

OUTGROWN HOMES

Once a year, therefore, until its full size is reached, every crab has to cast off its shelly covering and get a new one in its place. The going away and hiding among rocks or seaweeds is not from any sense of modesty but from the fear of its enemies. It knows that it will be entirely helpless, not even able to use its claws.

A strange thing takes place when this change begins. Something like a third part of its flesh turns to water. If you were to catch the crab at this time you would hear the swishing of this water inside the shell.

Then the crab gets very restless, and wriggles about, turning and twisting from side to side and rubbing its legs against each other. It rests awhile and then begins to twist itself about again. This is repeated till the shell is no longer fastened to the body at all. A rent quite suddenly opens right across the back, and the crab leaps out of its old coat, the rent soon closing up. For a little while the crab lies still and then begins to take on its proper size again. In less than twenty-four hours it is likely to be half as large again as before the change began, and in a couple of days a new shell will begin to form, and the animal will leave its retreat with a good new suit of stout armor to live in for another twelvemonth. The outgrown shells are left in perfect form as if ready for other creatures to use.

MASKED CRAB

HUNDREDS OF EYES

The eyes are one of the odd things about creatures like the crabs, for they see in a strange way. On each side of the head is a kind of stalk — you may have seen similar ones on the snail — and at the tip of each stalk is a small black spot. Under the microscope this spot is seen to be made up of hundreds and hundreds of very tiny eyes. A crab may have three or four thousand eyes. This sounds a very large number till you consider that the eyes cannot be turned from side to side or up and down. They are fixed and cannot be moved at all. Of these thousands of eyes some look upward, some downward, some backward, and some forward. Each eye acts like a telescope pointed in one way. It takes a great number to see in all directions.

All the Crustacea keep to the rule of a pair of jointed feet to each ring of the body; the

changes are shown in the way these rings and limbs are used. The prawn, for example, uses his second pair of feet to catch his prey and hold it, while the crab and lobster use the large, strong front ones. The shrimp can be told from the prawn by a kind of broad hand at the end of its head, with a saw-edged hook. When it is remembered that each of these changes in a creature stands for some new need met by a line of ancestors which has made it, the life stories gain in meaning, and the wonder grows as the knowledge increases.

HOW DO CRABS EAT AND WALK?

Another habit which seems quite intelligent is the way crabs eat. Give them a piece of fish and they will present a most comical appearance, going about eating it in a serious yet enjoyable way. With one claw they pull off a piece of flesh, and then pick at it with the other till a morsel is gained which is carried to the mouth and stuffed into it. They go on steadily till all the bone is picked clean.

In walking, the crab is awkward, as the fable tells us. The particular way crabs have of moving sidewise is the theme of an Æsop fable. A crab said to her son, "Why do you walk so one-sided, my child? It is far more becoming to go straightforward." The young crab replied, "Quite true, dear mother; and if you will show me the straight way, I will promise to walk in it." The mother tried in vain, and submitted without remonstrance to the reproof of her child.

PRAWNS, SHRIMPS, AND SANDHOPPERS

Down among the rocks and shallow pools when the tide is out there will generally be little shadowy forms darting about which, if they could be magnified to the size of a lobster, would look very much like it. These are the prawns and shrimps, which are difficult to tell apart save that the larger, rarer ones are likely to be prawns. In the South and on the California coast shrimp fishing is an important industry — for shrimps are a real luxury. Unlike some crabs, prawns and shrimps are free swimmers. When alive they have scarcely any color at all, and are nearly transparent, like the sand in which they can bury themselves in a moment, and in which the sandhopper may be seen at any time on a sandy beach.

The nimbleness of these little creatures is almost beyond belief. The damp sand is honeycombed with them, and on the edge of the water when the tide is coming in they leap into the air to a height of twelve to eighteen inches. Sandhoppers have so many enemies that the wonder is that any of them are left alive. Long lines of birds may be seen gobbling up the active little creatures by thousands. But it is well they are not all eaten, for they are very useful in feeding upon decaying seaweed and the rubbish which would poison the air. All these are the cleanest of creatures themselves. You may often see prawn in an aquarium making their toilets. The front legs with stiff little hairs make a pair of brushes, and with them the prawn rubs itself over till perfectly clean. If any object should cling to its body, the strong little pincers on the second pair of legs will pull it off. The cleanly habits of the prawn are proverbial.

The temptation is to pick up sandhoppers and hold them in a handkerchief, but in a few minutes they would have nibbled so many little holes in the handkerchief that it would be spoiled for use. The sandhopper's skipping feat is performed by doubling its body up into a circle and then straightening it out with a sudden jerk.

THE LOBSTER

No one will deny that the lobster, the king of the tribe, is a most curiously formed creature. It is nearly black, and only when boiled does it become the vivid red we know it by. For its size it is monstrously strong, and so fierce are lobsters that they are quite well let alone, unless one knows the one or two places by which they may be safely held. Made to be symmetrical as to opposite parts, the great claws are an exception, for one of them is much larger than the other. This is not because the animal has at some time lost one through accident or battle and is growing a new one in its place, but because one is naturally bigger than the other; and the reason for this fact is that one is a weapon with which to fight, while the other is an anchor with which the lobster clings

BIG CRABS AND LITTLE CRABS

1. This is the sleeping crab, his arms tucked closely round him. 2. Crabs eating. 3. The hermit crab. 4. Crabs fighting. 5. The angular crab: see the sharp angles his claws make. 6. Two tiny broad-claw crabs. 7 and 8. Small and large spider crabs. Notice the different lengths of the claws.

THE LOBSTER, KING OF THE CRUSTACEA

to the weeds that grow on the rocks on the shallow sea bottom. Fishermen sending lobsters to market in boxes have to put sticks into the fighting claws to prevent the ugly creatures from tearing off each other's claws and otherwise coming to harm.

HOW THE LOBSTER SWIMS

The swimming of the lobster is curious. The tail is made of broad plates, as you will see in the picture. These can be spread out much like the parts of a fan. They have a fringe growing all around them, and when a lobster swims he stretches his body straight out and then suddenly doubles it up. As he does so the plates of the tail spread out and form a broad and powerful oar, which strikes the water with such force as to drive the animal swiftly backward. With a single stroke the lobster will dart backward to a distance of twenty feet, and that so quickly that even the swiftest fishes could scarcely overtake him. But the lobster can also swim forward, and he does so, not by means of his tail, but by the five pairs of odd little organs underneath his tail, which are called swimmerets. Each of these consists of two tiny paddles, and by waving these the lobster manages to travel along with some little speed. The swimmerets serve another purpose, for the mother lobster glues her eggs to the fringes of her swimmerets, where they stay till ready to be hatched. Baby lobsters swim about freely till an inch long, when they leave the surface waters and begin to live at the bottom, hiding in nooks and crannies and leading the same kind of life as their parents.

THE HERMIT CRAB

The hermit crab has been more written about than the rest on account of his borrowing a home instead of providing one for himself. He is usually found tucked comfortably into the large whelk shell, and if you disturb him he will retreat and close the opening with his big claw. If the shell is not too large, he will travel about dragging his home along with him. The usual reasons are apt to be given and the hermit gets a bad name; but if you were to catch him out of his shell you would see that, though he has powerful claws and though his second and third pairs of legs are covered with stout armor, his long, fat body is only covered with a soft skin, and is therefore much exposed, being an attractive mouthful for many hungry creatures. From the time that the baby crab is a quarter of an inch in length on through its whole life, this crab is a house hunter, for his houses must match his growing size.

ACORN BARNACLES

A very remarkable little body lives in what we, thinking only of its shell, call a *barnacle*. You have seen rocks, wooden piles, waterlogged boats, and anything on the edge of the sea that will give them footing fairly covered with them. Most likely what you have seen are the acorn barnacles. They look like little molluscs but are much more closely related to the shrimps and prawns.

The top of the acorn-shaped shell has four little pieces which fit tightly together. The four parts make a trap door which can be

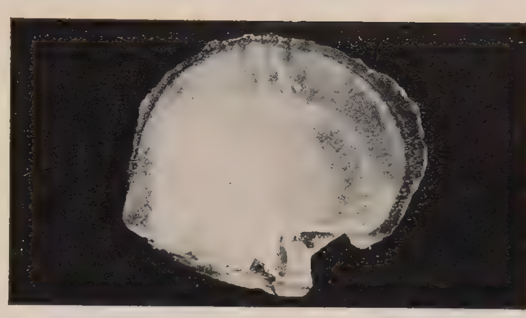
opened and closed at will. While you watch, one may open suddenly and a tiny tuft of what looks like feathers be thrust out; then they are drawn back and the trap door is suddenly closed. The tuft is not feathery, however. What you see are the slender hairy legs of the little soft barnacle, which seizes its food and kicks it down into its mouth. There are six pairs of these pretty curved legs, and as they are clothed with hairs they sweep through the water like a net. From the baby barnacle they go through extraordinary changes and have two names, before they are full barnacles. When this time comes they settle down for life, which is done by fastening with cement stuff in glands on the feelers around the mouth, and from this time on remain standing on their heads! Many a ship has had to be put into dry dock to have its sides scraped clean of the regular "forest of long gristly stalks" which in a long voyage come to hinder its progress through the water.

A BARNACLE STORY

A curious legend was made in the Middle Ages which came to be a popular belief till recent study gave facts which ended it. According to this story the stalked barnacle was partly fish, partly fowl, and in the end it turned into a bird called the "barnacle goose." These were supposed to exist in the islands of the Arctic seas. And on the shores of these islands grew the barnacle trees, their branches overhanging the seas. As the fruit ripened it burst from the shell and fell into the sea. Old Izaak Walton in his book published in 1653 quotes these lines from Du Bartas:

"So slow Boötes [a constellation] underneath him sees
In the icy islands, goslings hatched of trees, —
Whose fruitful leaves, falling into the water,
Are turned, 't is known, to living fowls soon after.

"So rotten planks of broken ships do change
To barnacles — O transformation strange!
'T was first a green tree, then a broken hull,
Lately a mushroom, now a flying gull."



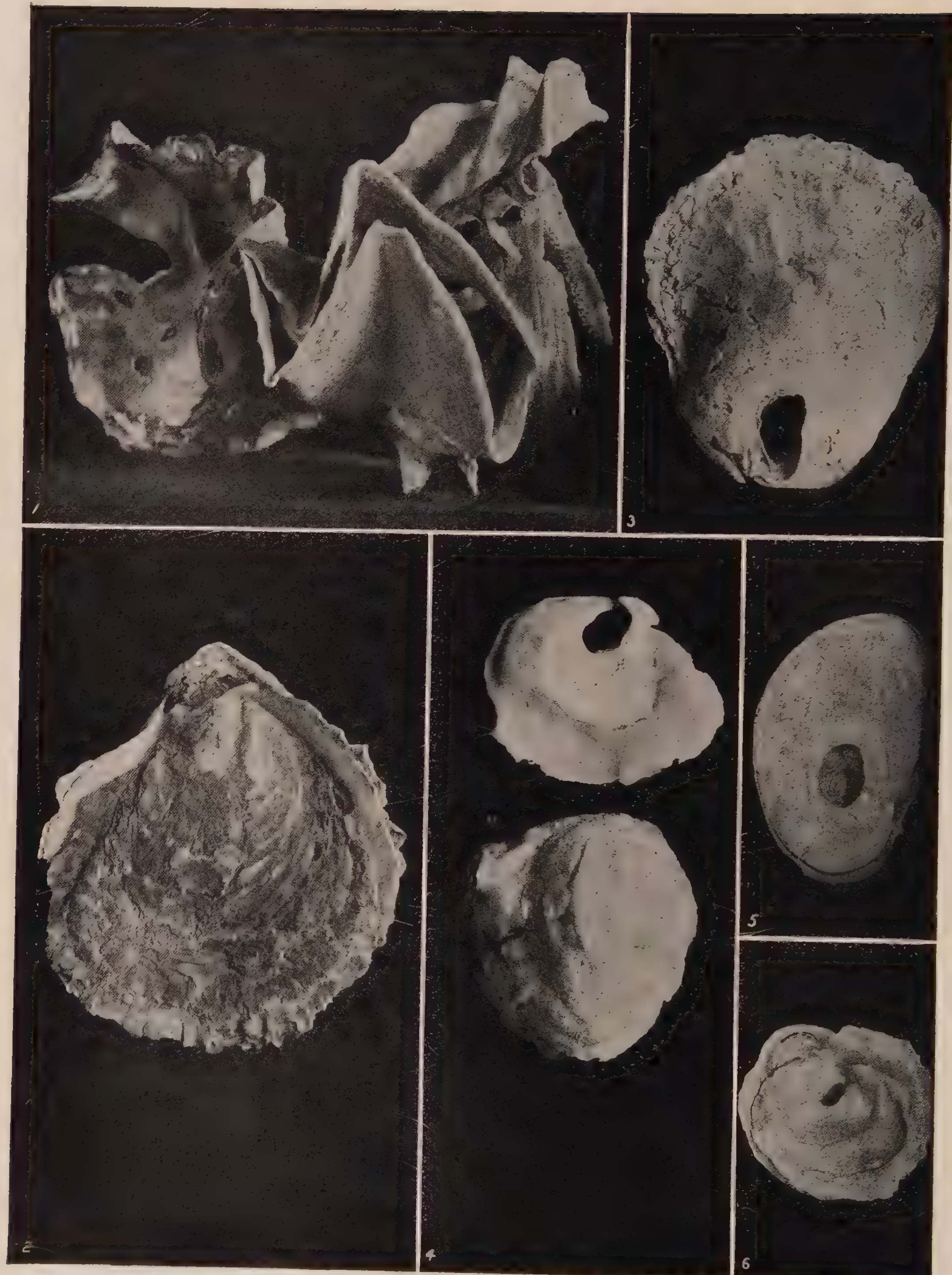
MOLLUSCA

MANTLE-COVERED ANIMALS

THE seventh great subdivision of the animal world makes a long step from the prickly-skinned creatures which without exception must live either wholly in the sea, or else be safely near it during the ebb of the tide. These mantle-covered animals are the *Mollusca.* The name is from a Latin word, *mollis*, "soft." The name is well chosen, for it is true that while many of them might as well be called hard, not all the Mollusca have a hard shell, while they all do have soft bodies. It is this soft body that calls for the shell to protect it. In a great number of the most advanced forms, special weapons of defense have done away with the need of a heavy shell, just as a man with a rifle would not be induced to burden himself with a coat of mail. But all the Mollusca show signs in their growth from babyhood of having been related to forms that had protecting shells. Millions of shells preserved in all parts of the world, not to say countless multitudes which have been crushed and broken, have once been the home of a living animal which was born wrapped in a mantle.

THE MAKING OF A SHELL

The wonder-working mantle which life has given to these soft-bodied Mollusca may easily be seen in any common shell-dwelling animal such as the oyster or the periwinkle. These two are types of two kinds of shell making. When an oyster is opened two transparent flaps appear, with thickened edges, one above and



From "Shell Book," Copyright, Doubleday, Page & Co.

OYSTERS AND JINGLE SHELLS

the other below the oyster. These, where they touch, inclose the animal between them. In the periwinkle the mantle is all in one piece, and is a transparent tube out of which the soft creature pokes its head and a crumpled foot which closes the lid.

HOW THE PERIWINKLE GOES TO WORK

When the young periwinkle was not bigger than the head of a pin and his shell looked like a transparent bead, he began to provide for growing larger and stronger. He stretched out his mantle till it reached over the edge of the shell and began giving out a thin film in which were grains of lime which had been passed into its mantle from its body. This film clinging to the inside and stretching over the edge made a new layer and a new rim to the mouth. The rim was colored by little cells of dark pigment, or dye, stored in the border of the mantle. The shell was now a little larger and a little thicker, and the mantle was drawn in till a more roomy house was needed for a child who, being alive, could not help growing. So the building went on getting enlarged as was needed, the lines round and round it marking the rims which had each in turn been its mouth. The enlargements can be counted in many of the kinds of shells. In this way not only the periwinkle but all the Mollusca build up their strong castles for homes and for defense.

AN OYSTER AND ITS SHELL

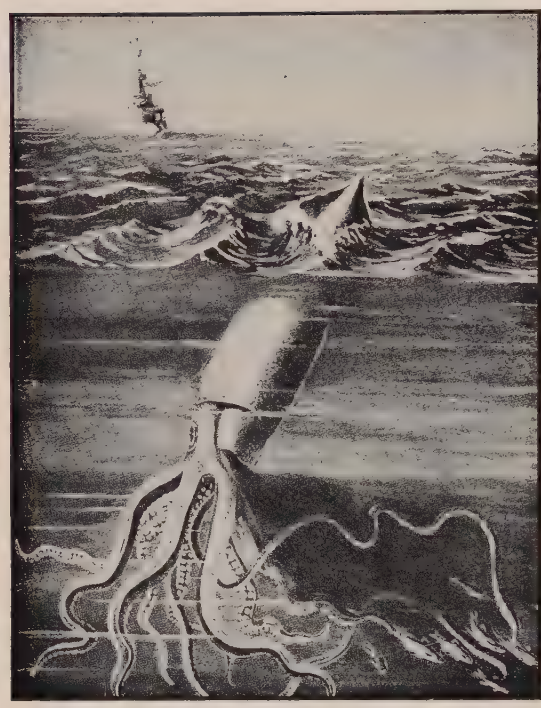
In the oyster each half of the mantle lays down its own separate valve, as all the Mollusca do which have no separate heads. These grow two-valved shells (*bivalves*), while those like the periwinkles, snails, and whelks, which have their heads and mantles all in one piece, are *univalves*. So each shell is a life story. The mantle's use is to make the shell, and the shell's use is to protect the soft form within, and each different sort of shell tells a different sort of story. The shells stand open naturally because they have an elastic cushion fixed within the hinge which acts like the spring of a jack-in-the-box to drive them up unless it is pulled down by a strong muscle, one end of which is fastened to the upper and the other to the under valve. When danger is near the oyster or clam can pull its shell together with a snap. If you could watch the oyster alive you would see that all the water passing over the transparent frills of four striped bands which make the gills, flows towards an opening in the right-hand corner. This is the mouth. And under the microscope you would see a whole forest of lashes or tentacles such as you are familiar with in lower forms. By this stream the panting oyster not only gets its breath, but also a host of helpless microscopic plants and animals which are drawn in and swallowed.

NUMBERING THE HOSTS

Shrimps, crabs, and lobsters multiply in such numbers that we need not be sorry that by far the greater part are cut off before they have time to grow up. A female crab has been known to carry at one time over twenty thousand eggs on the under side of her triangular tail, and some of the shrimps are not far behind. You can easily see that if all the babies that hatch were to live and grow up, there would soon be no room left for any other creatures of the sea. It is one of Nature's laws in both the plant and animal world that where the struggle for life is keen in the early stages there shall be a great number of seed and young.

INDIVIDUAL WAYS

If you wish to see how particular crabs take each its own way, turn loose again a dozen or so which have been caught and see what happens. One or two will tumble over and lie quite motionless, as if they were dead. One scuttles away as quickly as its legs will carry it. One will be brandishing its claws in a very ugly way, ready to do battle with all comers. Some will stay still but will bubble and foam with rage. Those that shammed death will have nearly buried themselves from view in the sand. So each takes its own method to try to get away from us. The crab mothers, if they were there and could talk our language, might say it shows how intelligent they are!



GIANT SQUID

The largest specimen known had a body 20 feet long; longest arm, 35 feet; a total length of 55 feet.

HEADFOOTED MONSTERS

THE name *Cephalopoda* (headfoot) is given to the hideous creatures of this class because in it the head and feet seem to be one and the same. If eight, or sometimes ten, writhing snaky arms springing from a head with cold, staring eyes do not make a hideous creature, it is hard to think what would. Yet if we do not have to come in contact with the cephalopods, there is something to wonder at and admire in the way they are equipped for the life they lead. They are molluscs, soft-bodied, yet naked; and soft-bodied creatures without shells could not maintain life in the sea without very special helps.

These strange creatures seem like freaks of Nature. We wonder at them. No good word is ever said of the octopus. But if man has no use for these creatures, fishes have. They consider them excellent food, and after all they are the ones chiefly concerned. The forms of all the species are similar, but the octopods have round heads, while the cuttlefish's head is cylindrical. Around a quite distinct head is the circle of arms, eight for the octopod cuttlefishes, ten for the decapod cuttlefishes, or more numerous for the pearly nautilus. These are all the outer organs there are. Breathing is by means of gills along the side margins, and a tube, or "funnel," acts like a siphon in keeping a jet of water flowing over them. The jet of water has other uses. It carries away all undigested food. A brown inky fluid, sepia, is secreted in an ink-sac in the body, and it is sent out on occasion through the funnel.

HOW THE CREATURES SWIM

Nothing like real swimming, in long distances, belongs to the cuttlefish tribes, yet they can make quick progress in the water. A very tiny squid can leap many feet above the water; they have often been seen on a ship's deck. When a cuttlefish needs to hasten it can send out a jet of water that will hurl it backward with force and speed. A broadening of the body into something like fins helps the creature to swim forward. Where there are ten tentacles or arms, one pair is much longer than the rest, and these are used in taking hold. They are also useful when the creature walks on them, head downward on the floor of the sea, or when it swims backward, perhaps trying to escape the sperm-whale, its most deadly foe. Could anything be more curious than the structure of these strange animals?

What makes the arms of the octopus and its relations so deadly in their grip is that hundreds of little suckers are all over the under side of them, and each of these works like an air pump wherever it lays hold. Each sucker is a cup with a muscular rim; and a vacuum is made inside it, so that the hold of these cups is amazing.

THE OCTOPUS

The common octopus does not grow to a great size, but a shuddering feeling comes over anyone who sees one in action. While its normal color is light brown splashed with reddish spots, it has the remarkable power of changing its color as it moves about. By taking on the color of

DIVERS FIGHTING A DEVILFISH

The body of this large member of the Octopus family is like an enormous bag; the arms, long and entwining, have suckers on the under side with which it holds its prey.

THE BLENNY

A little fish that can live two or three hours out of water.

AN OCTOPUS AT REST

Notice how he coils himself up in a small space.

its surroundings it escapes the notice of its enemies. When resting on the floor of the sea, with its eight whiplike, clinging tentacles peaceably curled and tucked away, it has been described as looking like a blob of jelly. From this creature, no larger than a football, dreadful arms shoot out, at the slightest touch, to the length of three or four feet.

A WADER'S ADVENTURE WITH AN OCTOPUS

A wader on a New Zealand beach tells of one of the long whips gripping his naked legs as if it were eating into the flesh. Before he could tear it off another and another had twisted themselves around, reaching to the hips. Though the water was shallow, the wader felt as if he would be dragged under and drowned. He remembered that he had a knife, and struck for what he thought must be the body of the thing and stabbed it. The grip gave way in a little time, and he saw the water all about stained with what he thought was blood. He found afterward that it was the brown sepia which each of these creatures holds in a sac within its body. A full-sized octopus could hold two men under water at once. It is fortunate that the creature is not given to swimming freely about, but only to crawling clumsily on the sea bottom, dragging itself along by its clutching arms with their dreadful grip. Sad stories are told of encounters of divers with one or another of these creatures, and many cases of drowning in seas where they are common are believed to be due to their deadly grip.

Marvelous stories have come down from antiquity of the terrors of these monsters. So dreadful were they that it came to be believed that there was no such thing as the gigantic cuttlefish even by people who accepted the stories of the sea serpent.

With the cuttlefish is associated the shell known as "cuttle bone," used for polishing powder; and with the octopus, the squirting out of the inky fluid, sepia, which fouls and darkens the water under cover of which the creature makes a retreat from enemies. These are articles of commerce.

COMMON SQUIDS

What are called squids are very abundant all along the New England shores as far north as Newfoundland Banks. Fishermen use them for bait. That cod and mackerel are fond of them is shown in a story of a certain mackerel — not, however, on the New England coast — weighing four pounds having been opened and twenty-four squid found in its maw. As it was in the act of getting one more which cost it its life, the fondness of fish for squids may be accepted as true. Where there are shoals of such fish as cod, the water is thick with the smaller kinds of squid.

GIANTS

Cephalopods range in size from the tiny loligo, two inches in length, to the giant squid, or cuttlefish, of which the limit in size is not

known. They have been seen of the size of the cachalot, or sperm whale. The range is through the whole ocean world and seas of all climates, from the Arctic regions to the hottest climes. Fortunately, those of greatest size are in deep, distant seas. And they are in general sluggish creatures, though capable of great exertion. The cachalot is probably the only animal that attacks the giant squid. Smaller creatures, like the large fishes, brush against a waving tentacle and find themselves held tightly, surrounded by sepia-colored water, and swiftly drawn down into the open chasm of the creature's mouth.

WHAT FEEDS THE MONSTER?

What vast amounts an animal must eat to support such amazing size! How does he forage for it? For the most part just as a huge spider does, waiting for his prey to come to him, his huge eyes watching, and the great chasm of his mouth wide open, the parrotlike jaws clashing on the victim as it passes into it. All that he needs must come to him, and as Mr. Frank Bullen has said, what an all it must be! Digestion is very rapid even in the smaller species, and the food is quickly dissolved, so that a creature so vast must be always calling for more.

VERY OLD STORIES

When we consider what accounts have been believed of the sea serpent, it is not strange that equally exciting tales are told of encounters with these seemingly fabulous monsters. One of the oldest of these goes as far back as the time of Pliny and Aristotle. It sounds incredible, but the accounts of the present day give the gigantic cuttlefish about as great size.

While Pliny was Spanish consul, he tells us one of these creatures had the habit of coming ashore at night and plundering the salt fish warehouses. It came once too many times and was slain. Seeing it, Pliny made it the occasion for a joke with his friend Lucullus in Sicily. He caused the head to be cut off and sent in a cask, which must have been larger than a sugar hogshead, to grace one of his celebrated banquets. The arms, he said, were thirty feet long and the sucker vacuum cups big enough to hold four or five gallons.

BUTTER FISH

THE PEARLY AND THE PAPER NAUTILUS

One of the most delicate and beautiful treasures of the sea is the shell of the pearly nautilus. There are only a few forms left in existence, but fossil remains show that they were once more numerous. A notable thing about the nautilus is that it is one of the few species of the cephalopods that has a shell. In the case of the paper nautilus, it is only the female that has it; argonaut is another name for this interesting little dweller in the China Sea and other similar waters. Stories of the argonaut as a kind of fairy craft are pretty to read, but, like other cherished stories told before science called for close observation and strict truth telling, they have to be given up for what is really the better story of how the nautilus makes the shell for a lovely cradle for her eggs.

Aristotle described the argonaut as holding up its spread-out arms like miniature sails to catch the breeze, while the rest of the long, slender tentacles made oars of themselves to carry them through the water.

Byron wrote of

"The tender nautilus who steers his prow,
The sea-born sailor of his shell canoe."

Pope tells us to

"Learn of the little nautilus to sail,
Spread the thin oar, and catch the driving gale."

And better than any is the poem by Oliver Wendell Holmes, "The Chambered Nautilus," which tells us to leave our outgrown selves and build us more stately mansions.

THE CHAMBERED NAUTILUS

BY OLIVER WENDELL HOLMES

This is the ship of pearl, which, poets feign,
Sailed the unshadowed main, —
The venturous bark that flings
On the sweet summer wind its purpled wings
In gulfs enchanted, where the Siren sings,
And coral reefs lie bare,
Where the cold sea-maids rise to sun their streaming hair.

Its webs of living gauze no more unfurl;
Wrecked is the ship of pearl!
And every chambered cell,
Where its dim dreaming life was wont to dwell,
As the frail tenant shaped his growing shell,
Before thee lies revealed, —
Its irised ceiling rent, its sunless crypt unsealed!

Year after year beheld the silent toil
That spread his lustrous coil;
Still, as the spiral grew,
He left the past year's dwelling for the new,
Stole with soft step its shining archway through,
Built up its idle door,
Stretched in his last-found home, and knew the old no more.

Thanks for the heavenly message brought by thee,
Child of the wandering sea,
Cast from her lap, forlorn!
From thy dead lips a clearer note is born
Than ever Triton blew from wreathèd horn!
While on mine ear it rings,
Through the deep caves of thought I hear a voice that sings: —

Build thee more stately mansions, O my soul,
As the swift seasons roll!
Leave thy low-vaulted past!
Let each new temple, nobler than the last,
Shut thee from heaven with a dome more vast,
Till thou at length art free,
Leaving thine outgrown shell by life's unresting sea!

THE FISH

THE EIGHTH WONDER IN CREATION

IT is a great step from the highest of the soft-bodied creatures, with or without a shell, to the fish. And it is the last of the great steps in the animal world. The fish is the lowest member of the highest class, but a member nevertheless. Beginnings are always interesting on account of what they may lead to, as pioneers in new fields are interesting. The fish is the pioneer of the backboned animals. The secret of their power to rise was the backbone, or skeleton. The parts of a skeleton grow out from a jointed backbone, and the separate parts of the backbone are called vertebræ. A hollow tube is formed by a ring in each vertebra, and in the tube is a line of nervous matter called the spinal cord. At the head of the backbone the bony substance forms a strong case or box, and holds a larger mass of nervous matter called the brain.

Animals of the fish, bird, or beast class, having vertebræ, are called *vertebrates*, and all below them, not having vertebræ, are *invertebrates*. These are the two first divisions of animal life.

ANIMALS WITH SKELETONS

The backboned animals are the only ones in life's great hosts that have inside their bodies living skeletons which can grow with their growth. This means strength, symmetry, beauty, and wider activity. The frame or support is not a thing apart from its life, a casing, or even a jointed armor of dead, hard matter, but a part of the life itself. Perfect skeletons did not seem to come all at once and ready made. A little two-inch-long creature still found on our shores shows what the beginnings may have been.

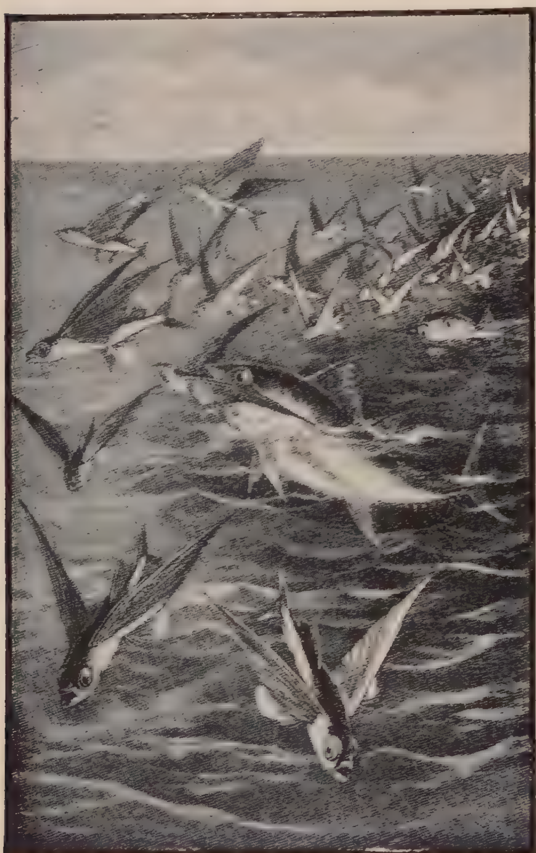
THE LOWEST TYPE OF FISHES

Not every fish is a good example of vertebrate life, though any fish you are liable to see will show the parts. The two-inch-long fish called the lancelet is interesting, because it seems to have vertebræ in the making. The parts are of a soft, tough substance called gristle,

POLES ASUNDER — A REMARKABLE CONTRAST OF LIFE

Here you can study out the different forms of animal and plant life found in the Antarctic and the Arctic Circles. The whales and seals are found in both, but the other animals are very different, and the few varieties in the Antarctic as compared with the Arctic are noticeable. By the way, of course you will not say "Ar-tic," but "Ark-tic." That "k" sound is important, as accuracy always is.

or *cartilage.* The bones of a very young child are soft, but those of the little lancelet ("lance-shaped") stay soft. It is a half-transparent creature, and only by an open mouth can you place its head. Two little spots prove to be feeble eyes, and one tiny pit with a nerve running from it has the power of smell. A flap on its back and tail are all it can boast as fins, and only by a



FLYING FISH

throb in the veins can you know how the blood is sent along, for it has no heart. It is only by courtesy that it can be said to have a backbone, but it has tougher cartilage along the line where the bone should be and above this line another rod which does duty for a spinal cord. It is not at all certain that this is the farthest back ancestor of all fishes and so of all vertebrates. It may be a degraded form of what was once a nobler type.

These gristly skeleton fishes keep on growing for a long time, and so come to a very great size. Few fishes fail to be cut off before they would come to a natural death, it is thought, and so the lifetime is a matter of doubt, but Pliny, whose story of the octopus is given, reports the life of a pike in which a ring had been put as being over two hundred years. And many report fishes known to have lived a century. It has been estimated that the offspring of a single herring, if allowed to multiply unchecked for thirty years, would not only meet every demand the world over, but become inconveniently numerous. Similar prophecy might be made for the cod, mackerel, and other fish families. The actual life, however, is probably very short.

THE GREAT BLUE SHARK

While you are upon fishes whose cartilage does duty for bone, you should meet one of the powerful specimens. Timid people at bathing beaches ask, "Is there danger from sharks?" and it is by no means sure that there may not be. The shark possesses no true bones. Sharks and rays are dreaded monsters of the deep. One of the rays, from having its side fins spread out like fans, suggests wings and is called the angel fish, but there is nothing angelic about any of these voracious gluttons of the sea. By a singular contrast in names the devil fish also belongs to the same class. They all have a bad name among fishermen, as every one of them is dangerous to man.

THE STURGEON

Sturgeon have the same soft skeleton. They grow to a great size, twenty feet in length, and often weigh two thousand pounds. Spending so much time in rivers, where they go to spawn, they are often counted among fresh-water fish. The mass of eggs called the *roe*, and containing hundreds of millions of eggs, weighs a fourth as much as the whole body, and is the chief value of the fish. Cleansing, drying, salting, and packing sturgeon roe is a considerable industry. In spite of its great amount of fat, sturgeon flesh is an article of food. Those which were caught in the Hudson River used to go under the name of "Albany beef," because they were shown in the

markets of that city. Sturgeon was thought to be a sumptuous fish among the ancient Romans. The *caviare* we eat is made from sturgeon roe.

ELECTRIC FISHES

Another celebrated member of the gristly skeleton tribes has two galvanic batteries, one on each side of the head. These are the electric rays. They are not as powerful as the electric eel, yet can still benumb the arm of a person touching one of them. The eel has numerous cells, and the torpedo seems to give shocks at will to other creatures, a most convenient way to gain control over them.

All these sharks, rays, and sturgeon families give one a queer notion of what a fish should be like, but they are interesting as varieties.

TRUE FISHES

Coming now to what answers to our idea of what a fish is, it is astonishing how little is known, by people in general, of fish life. It is not too much to say that, so far as man can interpret it, fishes have the merriest and most active life of any of the creatures, unless it be some of the insects. They are wise and wary, social for the most part, graceful and alert in their motions, and when seen in the water are beautiful in color. There are places where they can be seen to best advantage. Best known of these, perhaps, are the shores of Bermuda and the Barbadoes, where they are the delight of tourists. But if you will go out in a boat and anchor in any still sea that has a clean sandy bottom, more specimens will reward your watching than you are likely to meet of birds even in the heart of the woods. A goldfish in a glass globe is a good beginning of acquaintance.

The bones of fishes differ from bones of land creatures. They seem to be made of something like *enamel*, and the parts that go out from the line of the backbone are not jointed. Fish motion does not require great freedom except in the back and the fins.

FISH SHAPE

Long, slender, flatter a little at the sides, tapering at one or both ends, might describe a boat, but it is also our common idea of a fish. Has man learned to make boats of the water or the air from fishes and birds? It is to man's credit if he did, for the fishes did not learn it from each other, but only had it worked out in them by unseen power working in the line of their needs.

THE TAIL AS A PADDLE

Moving from side to side with quick, strong strokes, the tail of the fish acts as a paddle does in a boat. It is also used as a rudder in directing the course. Different forms and movements belong to different fishes according as they keep mostly to one level in the sea, as many of them do, or rise to the surface and go back again to deep water. These things show in the shape and set of the tail.

HOW THE FINS HELP

The fins keep the fish balanced in the water and help to steer its course. Big, strong fins belong to such fishes as must breast the strong waves of stormy seas; while some whose lives are spent in calm, quiet waters, gliding gently about

AN ODD FISH FROM THE DEEP SEA

or resting on the floor of the sea, have fins which are soft and small. After a little observing you should be able to tell this part of a fish's story by the kind of fins it has. Agassiz, who was one of the first naturalists to teach about fishes, could construct in his mind and give the right name to a fish from seeing certain bones.

A fish which must change the depth of water in which it swims will be sure to have just below the backbone a contrivance like an air bladder which can be quickly expanded like a balloon to

lighten the weight and send the fish up with no added effort of fins or tail; and by another impulse the swimming bladder is compressed when the fish wishes to sink to its place again. Fins, tail, and air bladder make the fish even more free in the water than birds are in the air. Airships as well as ships of the sea are built upon teachings gained from the bird and the fish. A gold fish which swam for a long time on its back was found afterward to have lost its air bladder.

FISH COVERING

The covering of fishes is generally of naked skin or overlapping scales. Another thing which man did not need to invent outright, since numerous orders of fishes had tested it, is the laying of flat plates so that one third of each is covered by the one below, leaving no open seams. We say that the scales are like the tiles or shingles on a roof, but it might better be said that man has put a scaly covering on his house like that of the fish. The scales are smooth, so that the surface makes no resistance to the water, as without nail or rivet the fish holds them tightly down.

HOW DO FISH BREATHE?

In many lower forms of sea life, water, flowing over surfaces which could take oxygen from it, renewed the blood of the creatures while it also brought food and carried away waste products. In fishes we come to true regular breathing apparatus. The gills of a fish are nearly, if not quite, as perfect in their powers as the lungs of land animals. A piece of the gill of a fish if put in water may be made to show the beautiful feathery parts over which water flows as freely as the outside water. This water, in passing over, parts with what it can spare of life-saving oxygen. A fish out of water can take little if any oxygen from the air.

THE FISH HOSTS

Hundreds of millions of eggs are found by actual estimate in the roe of some species of fish. Make allowance for a large part eaten in infancy by other creatures, and for industries supplying the markets of America and Europe alone, still all these are not sufficient to give an idea of the way fishes multiply. The fisheries of the world leave the population of the sea very little thinned out.

The herring family is an example. It was estimated many years ago that two thousand millions were consumed in Europe alone. Charles the Fifth, in 1556, erected a monument and ate a herring over the grave of a fisherman in the island of Zealand who had improved the art of preserving herring.

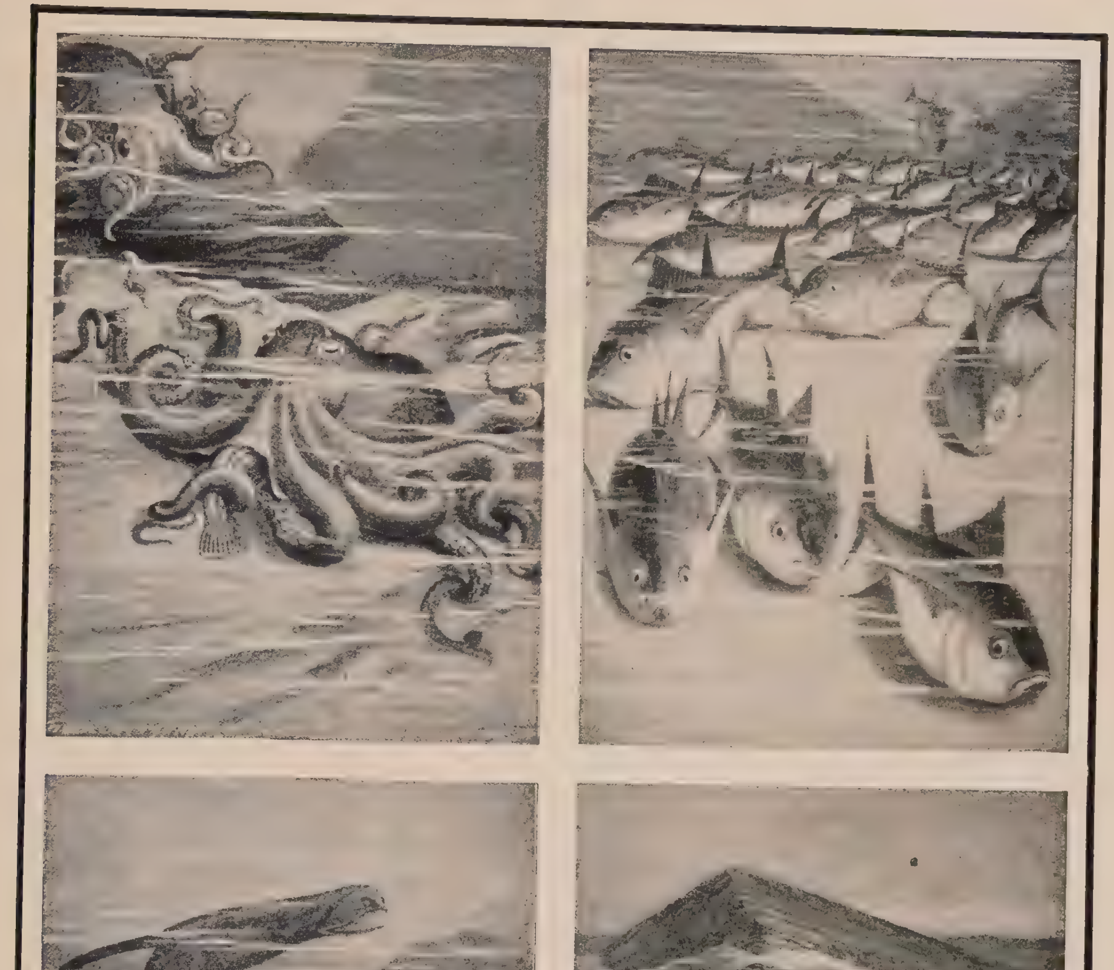
Sardines, a smaller species of herring, are taken, fifty thousand or more in a single hour, and four hundred thousand have been a single catch on the coast of Sardinia in the Mediterranean Sea.

WHAT DO FISHES FIND TO EAT?

Seaweeds, soft-bodied starfishes, sea anemone, and jellyfishes fill the waters where schools of fishes make their feeding grounds. It is true also that bigger fishes eat smaller ones even of their own species. It is the law of life to devour and be devoured, but the other truth should be set over against this one, that the creatures kill only for food. The quickness with which wounded parts heal, if wounds of battle are not mortal, helps us to waste little horror on what is called cruelty. If the lives are seldom free for long from danger, the fishes do not suffer either in fear beforehand or memory afterward. In general, Nature sets her children an abundant table.

A FISH THAT TRAVELS NEARLY ROUND THE WORLD

We know of bird migrations in great flocks and covering great distances. Not so much is known of the way great schools of fishes of the same species have different feeding grounds at different seasons. Think of the tunny, a kind of mackerel, sometimes called the *albacore*, making a trip nearly round the world every year. The spawning, or egg-laying, place for a great many is the eastern Mediterranean. That may be called the birthplace of the albacore. On shallows or rocky shores of islands the climate is favorable both for the young of the fish and for the food they need. It is the usual kind, proto-



By courtesy of Fleming H. Revell Co.

STRANGE FISHES FROM DEEP WATERS

These fine illustrations are from "The Denizens of the Deep," by Frank P. Bullen, a book to be read by lovers of the sea. The first picture shows the devilfish, or sea scavengers; the second is a school of females settled on the sandy sea-floor; the third depicts some of the freak monsters of the extreme depths; and the fourth shows the shark seizing his prey.

zoans, hydra polyps, such as have been described, medusæ, jellyfish, and other soft creatures swarming in the warm waters. Algæ grow in thick masses and make safe shelter for eggs and a place where the young may get their start in life.

The growth of the tunny is rapid, and when the weight comes to be two or three pounds the impulse to move on comes, and the migrating parties form, much as bird flocks do. Not all that were born live to get away, for other creatures know the warm banks as places to get food, and the numbers thin out as the course is taken on through the sea and out through the Straits of Gibraltar to the wide ocean. There are leaders for each of the schools, and order is maintained as they make their way down around the Cape of Good Hope. They stop to rest on the banks of Agulhas near by, where man takes toll of them in immense numbers, as fishermen do of cod on the banks of Newfoundland.

After feeding on the plentiful squid or cuttlefish of the Eastern Archipelago, they strike north and go by the Indian Ocean and China Sea, and then across to the California coast and up to Puget Sound, where young salmon hungrily await them. All the time the tunnies, or albacore, have been growing wonderfully fast. They feel less need of keeping in schools and are broken up into little groups, with new leaders, till some day a common impulse leads them to make their way back over the course. On this return trip they make fewer stops. All along the way they are joined by other schools and broken companies. A stalwart host, they go back around the Cape of Good Hope, up the shores and through the Straits of Gibraltar, along the Middle Sea, as the Mediterranean is called, with a fierce urgency, as their parents did a year before. Italian and other fishermen all along the coast catch them in great nets. This is a source of wealth on the shores of southern Europe, but each year, in spite of all that are caught, the supply is good again. The spawning season comes on the shallows and a new race is born.

This mackerel tunny is a beautiful fish, six or eight feet long, steely blue above with light shading, burnished silver below, and gleams with brilliant golden light. Off Barbadoes, or the Sicily coast, where the sands are fine and white and the water clear, they may be studied as birds are with a camera.

This is a general picture, but it serves to give an idea of all fish migrations — the cod being a familiar example on the North Atlantic coast.

TURTLES OR TORTOISES OF THE SEA

IT is only a single branch of the turtle tribe which has taken to the sea, unless it be true of the rest that in earliest times they were sea creatures who afterward came to live on land. For if we go back far enough, the sea is the great Mother of Life.

Even the sea turtles are true air breathers, and the mother turtles must come to land to lay their eggs in order that their children may start life on shore. This return to land, however, costs the mother dear, for man has learned the value of her flesh for food and the beauty of her shell for ornament, and takes this time to secure them.

WHERE TURTLES BELONG ON THE LADDER OF LIFE

It would seem that turtles belong before fishes in a rising scale of life, as other creatures do whose soft bodies need the protection of a shell. But turtles have many marks of a higher form of life, too many to describe here. They are closer in class to lizards, alligators, and serpents, for they have an internal structure that is less like that of the fishes and more like that of the highest creatures. The very shapely skeleton may be traced on the inside of the shell if the soft parts of the creature are taken away.

HOW A TURTLE MAKES HIS LIVING SHELL

The turtle saves himself from enemies by making a strong box to live in. This box, while he is living in it, is bound to be alive and to have the parts of a skeleton of regular form. A sea turtle is like a frog, so cased in armor that it cannot jump. How is it that the shell of the turtle is a skeleton? This is the way: The growing ribs of the young turtle while they are soft like gristle flatten out into bony plates and join themselves together so firmly that the shell would never break at one of these seams. These

rib plates, which protect the turtle, are joined also to the flattened-out sections of the backbone. There are twelve pairs of these scales; you can trace and count them. What takes the place in the turtle of a breastbone in creatures like birds, is spread out to make the under side of the boxlike armor. The joints of the neck remain free enough for easy movement, as do those of the tail. The row of plates all around the edge, twenty-three in number, bind the ribs together but do not belong to the skeleton, and are merely skin bones like our own nails.

LIVING INSIDE HIS OWN BACKBONE

How the shoulder and hip bones come to be inside the ribs instead of outside, as in other animals, is a puzzle till a baby tortoise is studied which has them outside just as other vertebrate animals do; but as the baby grows up the bony plates press forward to cover the shoulders and backward to cover the hips, till the creature appears to be living inside his own backbone and ribs.

HOW OLD DOES A TURTLE LIVE TO BE?

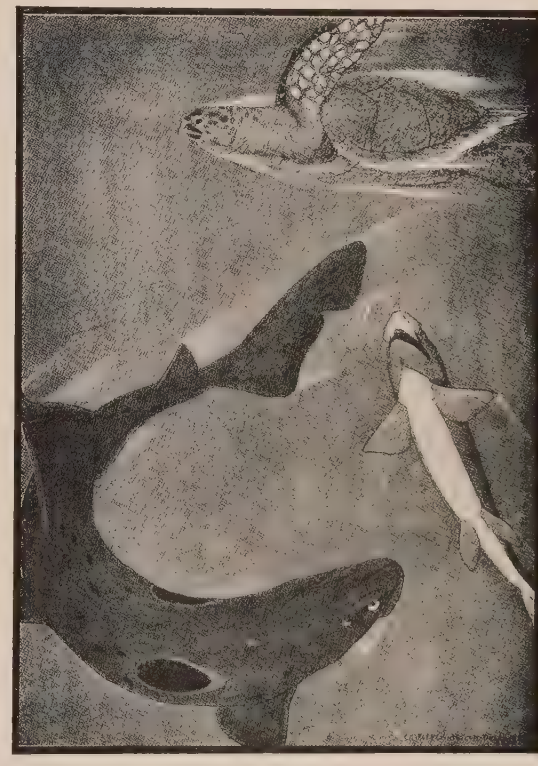
The tortoises have managed to hold their own in the world, yet against many dangers. Living slowly, they go on growing up to eighty years old; sleeping much of their time, they seem to ask but little of life. On land they shuffle awkwardly along, but in the sea they dive and rise or plow their way with great ease. Turtles swim mostly with their front limbs, the toes of which are joined and are flattened out to the shape of an oar.

Man is almost the only enemy the sea turtle has, and such a hold has it upon life that nothing short of utter tearing apart is fatal to it. An air breather, the turtle is also a water animal, for it can stay "below" a short or long time as it pleases, or come ashore for an equal period. The most of the creatures of the sea are the worst of gluttons, but it does not seem to matter to the turtle whether it eats or not, and it can go without light or even air to a degree that is marvelous. Except for short periods it is a sluggish creature, and makes up for living slowly by continuing to live much longer than do many other creatures.

TURTLE BREEDING

The mother turtle, feeling the weight of the eggs she carries, has an impulse to flee. On some fine morning her sluggish habit is exchanged for a rapid, rhythmical movement just below the surface of the water, and eighteen miles an hour is not too much speed for her to make. Such clumsiness to be followed by such speed is a marvel. Inside her shell she is in little danger from the hungry sea people, and like a miniature steam propeller her broad fans beat the sea like paddles. After a day of this unbroken voyage the great turtle comes to the place which she has been blindly aiming to reach. She drags herself up above high-water mark and rests. Her first act on coming to shore is furiously to fling her strong flippers, making the sand fly like a tempest till she is hidden in it from view.

Now for two days she will lay her eggs, one



A TURTLE SWIMMING

Even the hungry sea fishes make respectful way for her, as her shell makes her too formidable to attack.

hundred to eight hundred, according to the kind of turtle. Big, round, white eggs! Is it not comfortable to think of life so safeguarded that there do not have to be a thousand times as many to provide against catastrophes? The sun

CUTTLEFISH SWIMMING (above); ARGONAUT AND PEARLY NAUTILUS (below)

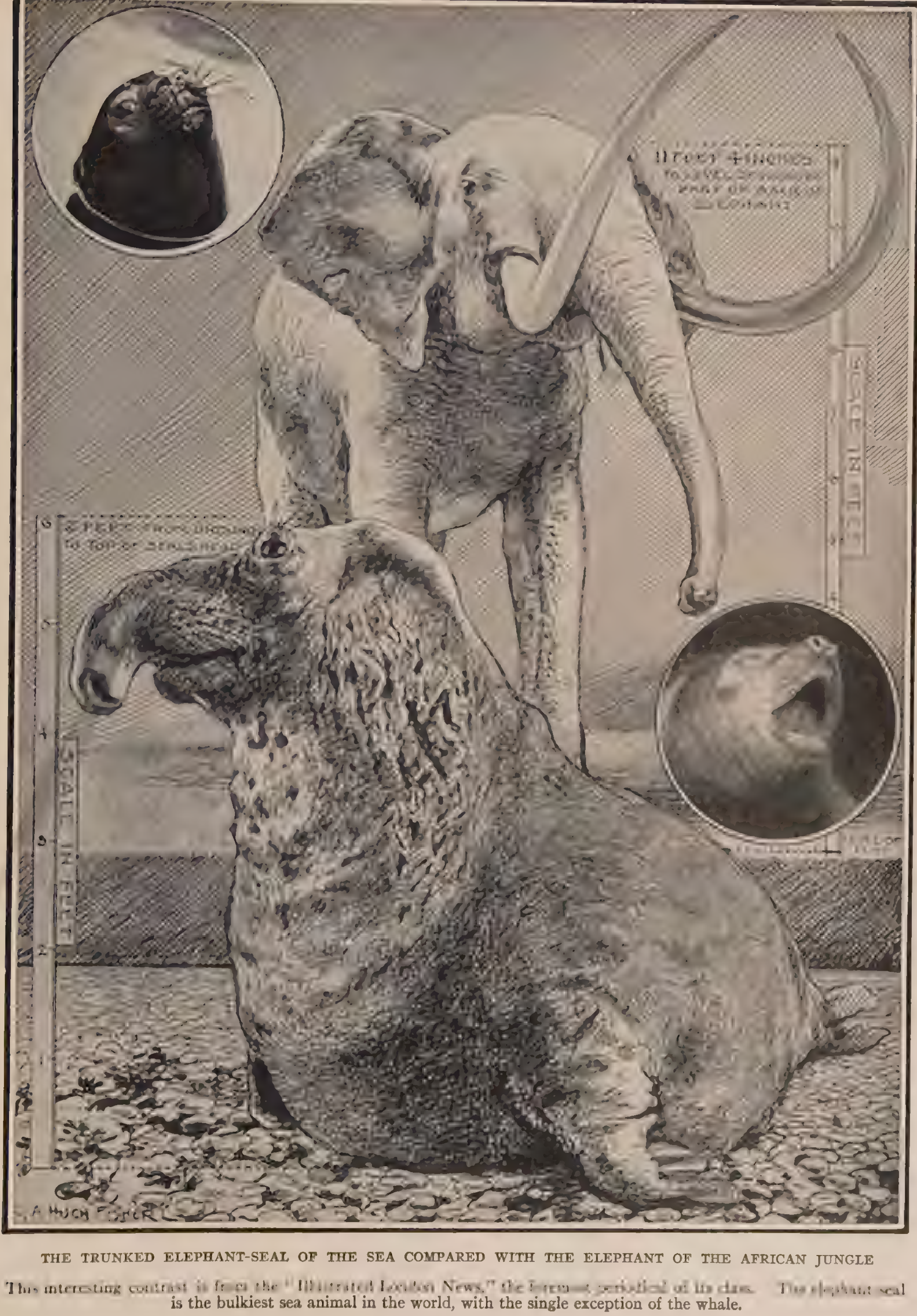
does the rest for the turtle eggs and the mother can go her way back to the sea.

TURTLE BABIES

If you were a creature weighing a thousand pounds, would you care to stay behind to see such tiny babies hatched, little black turtles, perfect, though the shell is soft, but only an inch across in size? The mother turtle does not think it worth while.

The baby turtle feels its need of shelter, and gropes about till it comes upon a patch of gulfweed whose branches hold numberless tiny living creatures. The other babies with the same instinct do the same, and the masses of gulfweed make a nursery for them all. When their shells become hard, which happens before long, the turtles take to the sea, and in a year's time are well out of danger, having a weight of twenty-five pounds, perhaps, and a thickness and hardness of shell which, unless the head and paddle legs are thrust out, makes the turtle practically safe.

The green turtle is four or five feet in length and weighs from four hundred to eight hundred pounds; but it has been known to double these dimensions and increase in weight in proportion. The flesh of smaller ones is of greater delicacy. Crocodiles live in the same waters as turtles, and both they and fishes are ready to spring upon the mother turtles when they are gaining the water after a visit to the shore. The flesh of the tortoise-shell turtle has not a good flavor, and the creature is sought for its fine clouded-colored shell. This outer shell is said to change every year, and great cruelty is practiced by heating a shell so that the creature will tear itself away from it. The shell, softened by boiling water, is shaped into whatever form is desired. A single turtle yields ten or twelve pounds of this valuable tortoise shell.



THE TRUNKED ELEPHANT-SEAL OF THE SEA COMPARED WITH THE ELEPHANT OF THE AFRICAN JUNGLE

This interesting contrast is from the "Illustrated London News," the foremost periodical of its class. The elephant seal is the bulkiest sea animal in the world, with the single exception of the whale.

THE STRENGTH OF THE TURTLE

It is better not to try to find out how strong the turtle is. Fingers have been lost by trying to see if a turtle was surely dead. Getting a hold upon a big turtle and trying to turn it over sometimes ends in being dragged down through the blinding sand it stirs up until one must let go or be drowned. Breeding time is harvest time for turtle capturers, who have only to succeed in turning the victim over to hold it safely. From the time it is caught the turtle will not touch food, however long it is kept in captivity before reaching the market.

HALF-IN-HALF CREATURES

IN the old myths we find stories of many beings half human and half animal — centaurs with the body of a horse and the head of a man, and mermaids with tails like fishes instead of lower limbs. As very often happens, the true story in this case is fully as wonderful as that which men imagined. The inhabitants of the sea which we call "half-in-half creatures" are not human and animal, but half water and half land, or half water and half air. They are the few which are left of the many prehistoric animals of which you have read in the earth-story, that lived on our earth when it was covered with water. Most of them died out when the waters fell and dry land took its place; but a few, some little and some big, were able to adapt themselves to the new conditions.

THE WHALE AS A FISH

Most people think of the whale carelessly as a kind of fish. It is only in what fits it for its life in the water, instead of in the air, that the whale is like a fish. Just what is it? One of the points of likeness between the whale and the fishes is the lack of a neck. The slim gracefulness of a spindle-shaped body does not allow outsloping shoulders. Creatures that move best in the water have their limbs folded closely to the sides and made to take as little room as possible. Fins are little more than long fingers which have found no use for themselves except to move up and down, or from side to side. The lack of a neck with freedom of motion for the head is seen to be more or less marked in all the vertebrates which live in the sea. A very flexible backbone has to make up for the loss of free motion for the head.

WHY MUST THE WHALE LIVE IN THE SEA?

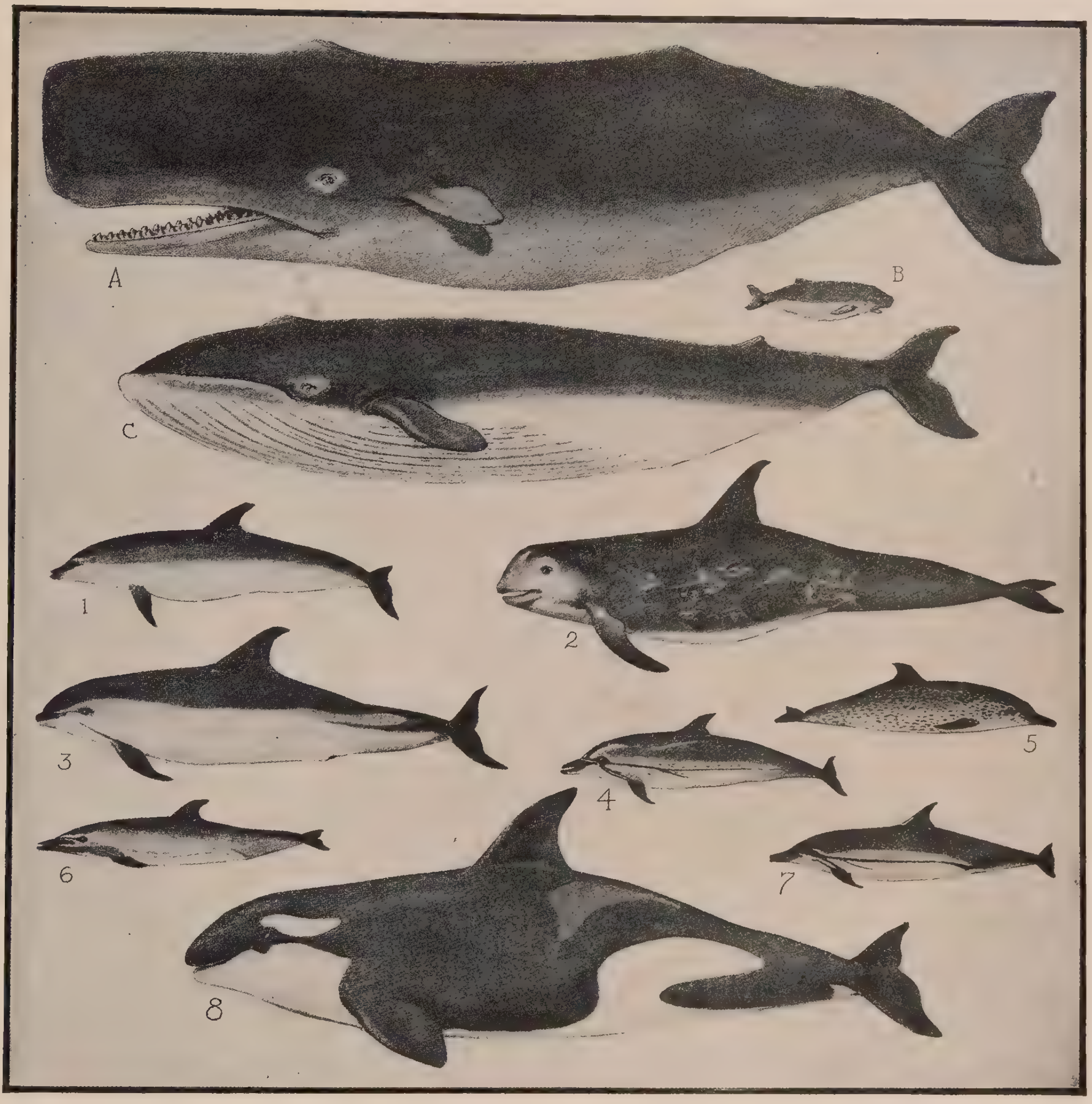
In the story of the giant cuttlefish we met the whale as the foe of the cuttle, which it eats. In mere size the two creatures do not vary much, but they are wholly different in form. We speak of the whale as sixty, eighty, or a hundred feet in length, according to the kind; and fifteen feet high at the head, if it is a right or Greenland whale. The cuttle is twenty to thirty feet between its outspread arms. It is plain that without feet such monstrous forms could not move about on land, and that they must live in the sea, where they have room to move about.

HOW THE WHALE SWIMS

The unfishlike way of breathing and living shows itself in the form and motion of the whale in the water. The tail of a fish proper is placed vertically. It moves from side to side. The tail of a whale is set horizontally. It moves up and down with tremendous force. While only five or six feet in length, it is eighteen or twenty in width. Because the greatest strength is in this upward and downward stroke, rather than in the sidewise ones, the whale is very swift in spite of its great size. From their rapid motion whales are called "birds of the sea."

Some kinds of fishes never rise to within a few feet of the surface of the sea, and never go below a certain known depth. They are not fitted for different weights or pressures of water. The weight of water in the deep places of the ocean is almost inconceivable. A whale of usual size would have to bear a pressure of two hundred thousand tons, or one hundred and fifty times as much as in air. The elastic coat of blubber could not resist such pressure if it were not a part of the skin itself, with its open fibers making a sort of India-rubber cushion. The oil of the blubber being so much lighter than water helps the whale in rising, and the pressure can be made to work under control in descending. It is a marvel of adaptation.

The whale is found in all waters, cold or



A GROUP OF AIR BREATHERS

A. Sperm Whale. B. Pygmy Sperm Whale. C. Finback or Razorback Whale. 1, 2, 4, 5, 6, 7. Porpoises and Dolphins. 3. Cowfish, or Grampus. 8. Killer Whale, or Sword Grampus.

warm, deep or shallow. It rests and feeds upon the sea bottom, but rises as often as every ten or fifteen minutes to breathe the air which is its life. The sperm whale takes sixty or seventy breaths in ten minutes or so. Then it goes below for an hour and a quarter, as a rule. Repeating these "breathing exercises" is a part of the regular life of the whale. Its warm blood is kept pure and able to endure the changes from northern to tropical seas and from light to heavy pressure.

MAN THE WHALE'S CHIEF FOE

In times of fury or rage the cachalot or sperm whale is one of the most dangerous and dreaded monsters of the deep. It can bite a stout boat in two, and the terrific onrush it makes towards a

ship would send the ship to the bottom if it were not gotten out of the way. Yet whales are playful creatures. The young ones will play about a ship for hours.

Whale fisheries are attended with great dangers, but there is never a lack of people who will face the danger and brave the hardship for the hope of reward. A quarter of a century ago the business of whaling threatened to die out, but now it has been revived, till it deserves a special story as an industry. In that story you will find out how many parts of the whale are valuable to men.

SEA PETS

The smooth dolphin and the porpoise are interesting as miniature whales. They are most familiar as seen from coast or ocean steamers. The porpoise may be sighted almost any day in summer. Passengers never tire of watching their graceful forms, the ease of their motions, and the playful gamboling with which they surround a ship as if to amuse and entertain those on board.

Dolphins belong more to distant waters, but with the more than sixty species, there are some for nearly all waters. They even go up wide-mouthed rivers. It is not difficult to tell the two apart, for dolphins have a quite extended snout, almost like a beak, and the mouth is rich with teeth, the dolphin having more than any other mammal, ninety in each jaw. It is not when the dolphin shows its teeth that one remembers the engaging qualities for which it is famed, but it does not open its mouth when sporting for us to see.

THE DOLPHIN IN HISTORY

The dolphin of story has a most distinguished pedigree. It was a great favorite with the ancients. Among the Greeks it was held to be sacred to Apollo, who was worshiped at Delphi with dolphin symbols. It is figured on many early coins. In the twelfth century the figure of a dolphin was on the shield of a family of princes, and Dauphiny, a province named for it, was given to the king of France on condition that his eldest son should be called the Dauphin.

This title was retained by the prince till 1830, when its use was discontinued.

The smooth, glossy skin in some varieties is brilliant, "beyond the power of words to describe," it is said. All the species are said to show wonderful changes in color when dying.

It is now understood, however, that many of the most remarkable ancient stories of the social habits of the dolphin belong to another fish of the same name. While playful, it is to be feared that the dolphin is rather wolfish in its ways. It destroys fish whose value is much greater than its own, and the way mackerel, cod, and herring behave in the water when a school of these animals is near by shows that they do not share our attraction to the dolphin or to the porpoise. But such considerations are forgotten when we see them darting about, in and out of the water by turn and hardly creating a ripple.

THE KILLER WHALE OR GRAMPUS

Among the dolphins the killer whale or grampus is the most bloodthirsty. It is the only one which feeds upon warm-blooded creatures. It seizes seals with its strong, sharp teeth and will devour its own relations, the porpoises. Even the larger whales are attacked by it and dreadful battle ensues. The mothers of the seal and walrus families try in vain to save their young. The grampus will swim under and shake them from the mother's back. How much a grampus can eat is told by those who kill and dissect them. Fourteen seals and thirteen porpoises are named in one of the stories.

FIN-FOOTED CREATURES

The seals and their fin-footed relatives make a group by themselves. They are the natural kind of creatures for such places as the Aleutian Isles, the entrance to Behring Straits, Nova Zembla, and Greenland. They have what they plainly need, flippers for the sea and true feet for the land. The front paws are more like feet, and the hind ones like flippers, or even fins. The skeletons show all the kinds of bones which a land animal has in its limbs. The packing of so much fat around the parts, and using these parts so little for walking or holding, has

ON THE NORTH SHORE OF THE ATLANTIC

Where the surf breaks on the rocks, and in storm the spectacle is grand beyond description. Painters frequent this rockbound coast.

given us a half-in-half creature which, when we see it for the first time, seems a freak. As we get acquainted with the funny creatures,

THE SEA OTTER

with the almost human look in their eyes, we come to admire the skill shown in their forms.

THE SEAL

The seal is one of the several great air-breathers that make their home in the icy seas of the polar regions. There he is looked upon as the greatest blessing of the half-starved human beings to whom his flesh is meat and his oil is light. The seal was planned to be a land-liver, but found he could adapt himself to sea life if he would exchange flippers for front legs and unite his hind legs with his tail to form a swimming fin. So his land movements are impossibly awkward and his gait sadly slow, though he can waddle on his fin-like feet. Being an air-breather and living in the water necessitates his coming to the surface to breathe; when under the ice, he has to make a hole in the ice to breathe through. This habit often costs him his life.

Several observers have noticed that the common seal is very fond of music, and one writer tells how the sound of his flute would bring a number of seals out of the water within twenty or thirty feet of him.

THE SEAL FROM WHICH WE GET OUR FUR

The otaries, or fur seals, are distinguished from other seals by an external (outer) ear. They are found in great herds off the coast of Alaska in the Pribilof Islands. When the seal hunters first came to the islands the animals were so tame that they would even look on while their companions were being killed. But now they have learned a little wisdom, and take care to climb to the top of a rock or steep place, where they can throw themselves into the sea.

The hunters have been foolish enough to kill so many seals that the industry has been threatened with extinction, as well as the otary itself. In recent years, seals have been taken under the protection of the United States and other governments. Only so many seals are allowed to be killed each year. Thus the seal is saved from total extermination or destruction. The seal of our caps and coats looks very different from the covering of the live seal. The long gray hair of his coat has all to be pulled out before you may discover his value in the fine yellow-brown fur that is hidden below. This under-coat must be "London-dyed" to give it its full money value — hundreds of dollars for a single garment of Alaska seal.

THE SEA OTTER

Those who are familiar with the form of the common otter can trace the preparation for sea life in the sea otter, which has almost wholly forsaken the land. Weird-looking creatures they are, as they are seen in hundreds off the coast of California and Alaska. Till something startles the mother otters they bask in the sun on the wet rocks. At the slightest fear each mother will pick up her little one with her teeth and dive under water. Except when caring for their young the sea otters hardly need the support of land. Turning on their backs they can divide and eat their prey, holding crabs, sea urchins, or fish in their front paws. It is most interesting to watch them. They play with and nurse their babies in the same pretty fashion.

But while this kind of otter has all the freedom of the sea life, it is distinctly four-footed, almost even four-legged, for its form is much like that of a weasel. Land and sea, like two good fairy godmothers, seem to have brought each her own best gifts to the christening of the otter, a land creature whose destiny it was to be to follow the sea.

THE TARPON TRIES HARD TO BREAK AWAY

FLAPPING DEFIANCE AT HIS CAPTORS

CAPTURED AT LAST

GETTING TIRED OUT

A MONSTER AT CLOSE RANGE

TARPON HUNTING

THE POLAR BEAR

Since so many people have been attracted to the Arctic seas, and explorers have described their winter quarters when icebound, we do not think the life of the polar bear so marvelous as we formerly did. Indeed it is in the bear's white coat that the Arctic explorers are kept safe; and it is when these men return to lower latitudes that they "take cold." The polar bear is a most interesting animal in the way it is suited to the icy waters where it makes its home. No land bear can twist and turn as it does. The polar bear's body is longer and its spine is more flexible. One has been seen forty miles from any coast and with no ice in sight to give it a rest. For movement on land the soles of the polar bear's feet are covered with close-set hairs, a special help for climbing the slippery ice cliffs. It is only the female bear which hibernates; that is, goes into a cave, which perhaps it may make for itself, to sleep away a part of the year and make ready to bear and rear its young. Both father and mother share in the care of the two cubs, and most interesting tales are told of their devotion. This is the time when the bears are most ferocious.

As a seal hunter, the polar bear is unexcelled, but much of its diet is obtained from floating carcasses of whales and fishes. The average length, when fully grown, is six to seven feet. It is entirely white, except the tip of the nose and the claws, which are jet black.

A VEGETABLE FEEDER

The impression all these creatures make is of devouring and being devoured. It is the law of life with them. There is no unnecessary torture, and it is good to remember that beyond the needed instinct to avoid danger there is no fear of death. The sea cow, on the other hand, is a gentle, peaceable creature, which feeds upon vegetable food, grasping the seaweeds with its upper lip and nipping them off with horny plates hanging from the roof of its mouth. A family of sea cows, father, mother, and child, has been seen wandering up the great rivers of South America or Africa, feeding under water, and only lifting heads out of water with a snort to take in fresh air. They must have been much more numerous in the forests of seaweed of older times, one to two hundred years ago; but sailors found them good eating and their ranks were thinned. It is probably the sea cows which have given rise to the stories of mermaids. No traces of hind limbs are shown in the thin, wide, shovel-shaped tail, not set edgewise, but so as to lie on the water like a leaf. The front limbs are as good hands and arms as are those of the seal. The sea cow, or *manatee*, as she holds her baby to her breast looks like an uncouth mother with her child. In the dugong the front teeth grow to form good-sized tusks.

BIRDS OF THE SEA

IF it is shown that any of the bird tribes belong to the sea more than to the land, then not one of the larger classes of vertebrates will be without its representative in the ocean world. The reptiles, it is true, have only the sea tortoise or turtle and some near relatives. We could hardly have expected that every great class of the animal kingdom would have a showing in the sea, but so it is, and it is also true that, on the whole, the sea is a better place than the land for studying the steps from lowest to highest in their natural order in the classified animal world.

THE SEA GULL

Passengers on the ocean steamers going between America and Europe always watch the gulls that fly around the ship. There will be a great flock of them at the start, but they thin out, till perhaps only four or five remain. They act as if they were really meaning to go across to Europe. By the third day the last one is missing, and the straggling ship's escort is making its way back to the shores it left. We should like to think that the birds follow the ship for social reasons, but it is probable that the tempting food thrown into the sea by the ship's cooks is the secret of their devotion.

THE STORY OF A PET GULL

Yet gulls are easily tamed. A story is told of a gull caught near Montrose by a Mr. Scott. He cut its wings and put it in his garden, where it

PHOTOGRAPHING A POLAR BEAR

1. Approaching him. 2. The king of the North. 3. Captured. 4. A rush away. 5. Escaping. 6. The farewell look.

BIRDS OF THE SEA

1. Blackhead gull and common gull. 2. Puffin and guillemot. 3. Giant penguins. 4. Albatross. 5. Pelican. 6. Manx shearwater and tern. 7. Puffins.

lived happily. It came to the door to be fed, and answered to its name, "Willie." The wings grew long again, and the bird finally joined a flock of gulls and flew away. It came back from time to time to pay visits, and kept up its tame habits. At the end of the season Willie went away with the flock, but to the great joy of the household he returned the next year. In this way he came and went for forty years. He visited the family, ate out of the hand of any of them, and answered to his name. One year he failed to come. The family mourned over the loss of their pet. A year later a servant came to the breakfast table one morning to say that Willie had come back. In a year or two after this the bird failed to appear. Gulls are seashore birds rather than sea birds. They sometimes go far inland in rivers and lakes.

Terns, or sea swallows, are smaller than gulls. They are most elegant in their forms and graceful in their movements. They migrate to southern waters in cold weather.

THE GUILLEMOT

Guillemots are seen much farther out to sea than gulls. They are known by their black and white plumage, their short necks, and their long, sharp beaks. A guillemot is from six to ten inches in length. Vast numbers of these birds gather on some rocky island at breeding time. Dr. Kane, the first of our Arctic explorers, wrote that it was not uncommon to take a hundred guillemots in a couple of hours. And Sir John Franklin salted and stored a two years' supply for his ill-fated vessel. The guillemot lays but a single egg on a bare ledge of rock. The egg's peculiar shape makes it roll round and round instead of falling off. Guillemots dive and fly under water to get their meal of small fishes.

THE STORMY PETREL

The stormy petrel is a bird of the wide ocean. It rarely comes to land except at breeding time. Always on the wing is the story of the petrels which will follow a ship for days, resting only on the sea itself. The same petrel has been seen in two places half across the world. Sailors tie bits of cloth to a petrel's leg, marking the place and time of seeing it.

No one need doubt that stormy petrels enjoy a storm. Long before sailors detect signs of a storm, these gloomy birds will gather in large numbers and make their piercing cry as if to warn the crew of coming danger. They may be seen in great flocks skimming the water, or diving into it to catch fish which do not come to the surface.

One of the petrels is called the Cape Pigeon, and but for its webbed feet the petrel is not unlike a pigeon. Some varieties are sixteen to eighteen inches in length. The giant petrel is nearly twice this size. As companions of the lonely whalers these birds have come to be much beloved. The rocky St. Kilda, one of the western islands of Scotland, is a famous breeding resort for petrels. Great rocks are covered with them. Mother Carey's chickens, a small kind of petrel only about six inches in length, look like chimney swallows in the length and spread of their wings. The plumage of most petrels is black and white, with purple reflections.

The name "petrel" is a form of the word Peter. It was given to these birds from the ease with which they walk or run long distances on the water. Some of the petrel habits are rather unpleasant. It has a bad name as a robber of other birds' nests, and some species dart at gulls or other birds which have birds in their bills and make them drop their food so as to catch it themselves.

THE ALBATROSS

The biggest of the petrels is the albatross, which measures as much as eleven feet between its outspread wings, and is fully four feet from beak to tip of tail. A curious fact is related of the albatross. When it wishes to rise from where it is resting on the sea it has to run a long way, like a running ostrich, before it can mount in the air. Sailors give the bird a toss or lift it quite clear of the ship's rail if it has lighted on board. The nest of the albatross is a pile of sticks, heath, and long grass, about two feet high. Where these nests are found there are apt to be penguin nests in a circle around them. The penguin burrows in the sand, and as many as eight nests may surround one of the large albatross nests. The eggs are much valued by the people living on the shores near their breeding place.

BIRDS IN PINAFORES

Auks and penguins belong among swimming birds. Their odd little wings help as paddles. The covering is of short, thick feathers which are almost like scales. Stories are told by sailors of the giant auk, but the race is now extinct. These auks used their wings so little that they came to be unsafe on shore. The whole tribe has been killed off.

Penguins are found in the south temperate zone. They cannot fly, but the wings help them in diving. Their movements in the water are quick and graceful. On land they are awkward. Great camps and rookeries of them show how social they are, but their bird government cannot be of the best when the stronger steal the eggs of the weaker. The king penguin is said to be the greatest thief of all. One called the jackass penguin sets up horrible brayings at nightfall. Penguins are nearly erect as they sit on the edge of a high cliff. They have been compared in their attempt to walk with a dog which has been taught to dance a minuet. And yet the birds are well furnished for the life they lead, except that man has discovered their great rookeries only to destroy them. It has been said that auks and penguins have the qualities of men, fowls, and fishes. Like men they stand erect, like fowls they are feathered and lay eggs, and like fishes they swim.

THE PELICAN AS AN EMBLEM

The brown pelican will be the last of these interesting, though odd-shaped, birds. Sea birds are all gluttonous feeders and their flesh is full of oil. The most of them resort to robbery, piracy, and utmost cunning in getting their food.

Pelicans are large, heavy birds. They are very awkward in their motion on land. As swimmers they can distance their pursuers. Their odd appearance is due to their tremendous bills and a pouch on the lower side, in which they can store fish which they catch, so as to eat it at their leisure. One of the pelican's ways is to disgorge its food after it seems to have swallowed it. It does this to feed its baby birds. Books of emblems have shown this bird as tearing open its breast to give its own blood to its young. It is used as an example of mother love. Modern observers have gone back of the pretty story to find what is probably the fact. The truer story may be that drops of blood from fish which the mother is crushing to give to her young stain her white breast. These birds serve a useful purpose in taking care of the offal from dead whales and other sea creatures. Pelicans are found on the Florida coast in winter, but go to inland lakes to breed.

THE LAST WORD

The study of life in the sea shows us many things we had not always realized. First, that the sea is almost a world in itself full of living creatures, and of vegetation of wonderful variety. Both plants and animals multiply with marvelous rapidity. Only as it is the law of their life to prey upon each other is the number kept in proper bounds, as rabbits threatened a few years ago to multiply so fast as to ruin the farmers of Australia. Another thing is at first a surprise: It is that, different as water creatures are from land creatures, those of the same range of powers obey the same law of life and are really very closely related. Thus the insects on land are close cousins of the shrimps and crabs.

Another thing shows plainly in life in the sea. It is that each grade is higher than the one before in some new use of the same powers. The new kinds did not come ready made, as it were, like a separate creation. No single upward step was too great for some adventurous member of a species, possibly, to have begun to take it; and, as life helps those that help themselves, in time a new species came to be. This is called *evolution;* and as now understood, is one of the newest wonders of the world, though all the new forms came and made creation complete long ages ago. The whole story of the animal creation is as if one life spirit ran through all, from the tiniest cell to the most perfect vertebrate. Follow out this idea and you will not be far from an understanding of the story of life.

AMERICAN ANTIQUITIES

PROMETHEUS MAKING MAN

IN THE CHILDHOOD OF MAN

QUEER OLD STORIES OF HOW MAN CAME TO LIVE ON EARTH AND WHAT HE DID

IT is strange to think of the earth with no human beings living on it. And yet we all know that there must have been a time when this was true. Every creation story ends with man. The earth is made; seas, rivers, mountains, valleys, and plains are formed; living creatures of every sort are created. But still the world is incomplete, and then the creators, whether they be the gods of Greek myth or the coyote of the Indians, decide to make man. Every tribe and every country has its myths about the first man and the first woman. You will see how the stories vary with the character of the peoples and the kind of life they lived. Think as you read that each tale is the answer worked out by some tribe for its questions about the creation of man. Before you learn what our wise men of to-day tell us about the childhood of the world, you should know some of these old stories, told by people who lived nearer to the time of the first man and woman than we do, and who really believed these stories as they told them. The Indian stories are especially ingenious. It is also very interesting to notice how many points of resemblance there are in the tales.

This first story is the California Indian tale of how man was made by Coyote, the Creator.

HOW ALL THE ANIMALS TRIED TO MAKE MAN

All the animals sat round in a circle. There were Lion, and Bear, and Deer, Sheep, and Owl, and Mole, and all the rest, down to little Mouse, who sat at the left of Lion. Coyote was in the center. He had called the council of the animals to tell them that it was time to make man.

"We must make man," said Coyote. "How shall we do it?"

"That is very simple," roared Lion. "Give him a mighty voice to frighten all the animals, and strong paws, and big sharp teeth. Then he will be master of the world. Never fear!" and Lion gave a deep rumbling laugh, as frightened little Mouse shrank away from him.

"Not at all," growled Bear. "It is perfectly ridiculous to have such a great voice. Half the time it frightens the prey so that it has time to get away and hide. Let this man which we are going to make move quietly and swiftly. And let him have great strength to hold what he captures."

"But think," interrupted Deer, "how foolish he would look without antlers to fight with. I agree with Bear that there is no sense in giving him a roaring voice. I should pay less attention

to his throat and more to his ears and eyes. Have his ears as sensitive as a spider's web, and his eyes like coals of fire."

"Ba-a! ba!" bleated Sheep. "What is the use of antlers? They always catch in thickets. You would do better to roll up the antlers into little horns on either side of the forehead. That will give his head weight and make him able to butt harder."

"You animals have no brains," interrupted Coyote. "You each want man to be just like yourself. You might as well take one of your own children and call it *man*. For my part, I know that I am not the best animal that can be made. I can make one better than myself or any other living creature. Of course I wish him to have four legs like myself, and five toes. But Bear's toes spread out straight so that he can stand on two feet. That is a good way. I want man's toes to be spread out like Bear's.

"Then, too, man had better have no tail, for tails are only good for fleas to ride on. He may have a voice like Lion's, but he need not roar all the time. As to giving him thick hair, that would be a burden. Look at Fish. He is naked, and he is comfortable under the hottest sun. So I want man's skin to be like the skin of Fish. As to claws, they should be like Eagle's, so that he can carry things. Deer's eyes and ears are good, and his throat, too. So I would make man with ears and eyes and throat like Deer's.

"Then there is one more thing. No animal besides myself has wit enough to rule the world. So I must give man some of my own wit, making him crafty and cunning and wise like me."

"Well, well," said Beaver, "there has been a great deal of foolish talk here, but no one has spoken of one very important thing. How could man live without a good broad tail? How could he haul mud and sand to build his house without a tail to carry it on?"

"And I," said Owl, "think you are perfectly senseless not to think of giving him wings. I cannot see what use anything on earth would be to him without wings."

"Pu-u-u!" sniffed Mole. "It is senseless to have wings. They only bump you against the sky. And eyes are useless, too. The sun only burns them. It would be better to give man a soft fur, and let him cuddle down in the moist, cool earth."

"Living in the earth is the worst nonsense of all," called out Mouse in a funny, squeaky little voice. "He will have to creep into the sunshine to get warm. And he needs eyes to see what he is eating."

"Oo-reech-oo!" shrieked Screech Owl.

Coyote spoke sharply, saying, "Stop your screeching. You may all go home. I will make man myself."

Then the animals began to quarrel, and the council broke up. Coyote flew at Beaver, and Screech Owl jumped on Coyote's head and began trying to lift off his scalp.

Each animal echoed, "I'll make man myself," and they all rushed quarreling and snapping to the clay bank. Each began to model a figure.

At sundown they stopped to sleep, all but Coyote. He went on working. When he heard snores from every bush, he went among the models of the other animals and destroyed every single one. Then he returned to his own figure and worked steadily. Gradually the clay took shape. When the figure was finished, Coyote looked at it, and saw that it was a man such as he had pictured. Then Coyote, the Creator, said, "Let this figure live and be a man." So Coyote made man and gave him life.

THE BABYLONIAN CREATION STORY

The Babylonians tell the creation story in a different way. There was no heaven, and no earth, and no light, and all the universe was ruled by Tiamat, the great goddess of chaos and darkness. Marduk, the Babylonian god of light, rose up, and in a fierce conflict, using the winds and the lightning as his weapons, overcame Tiamat, and split her in two parts like a flat fish. One half of her he set up and made a covering for the heaven so that the waters above could not come down. He laid the other half upon the waters below, and that made the earth. Then he made stations in the heaven for the other gods, resembling the stars. He caused the moon god to shine forth, entrusting to him the night, with power to determine the days. He caused the green plants to spring up on the earth and he made all kinds of cattle and larger beasts and creeping things.

A WINTER MORNING IN THE ENGADINE

When the other gods saw his wonderful works, they burst forth into a hymn of praise to the great god of light. When Marduk heard the word of the gods his heart prompted him and he devised a cunning plan. He said, "My blood will I take and my bone will I fashion; I will create a man who shall inhabit the earth, that the service of the gods may be established and that their shrines may be built."

This story was found recorded on seven stone tablets discovered in the ruins at Nineveh only a few years ago. The tablets are now in the British Museum.

THE BABYLONIAN FLOOD STORY

Ut-napishtim, the Babylonian hero of the flood, tells the story himself. He begins by narrating how the gods, Anu, Bel, and others, had determined to destroy the city of Shurippak where he lived. Ea, the god of wisdom, had warned him to escape by building a great ship.

Ea said:

"Frame a house, build a ship;
Forsake thy possessions, seek to save life;
Abandon thy goods, and cause thy soul to live.
Bring into the midst of the ship the seed of life of every sort."

Ut-napishtim began to build the ship. He built the hull and six decks. He looked out for a mast and all things that were needful.

When he had finished, he said:

"With all that I possessed, I laded it;
With the seed of life of every kind that I possessed, I laded it.
I took on board all my family and my servants,
Cattle of the field, beasts of the field, craftsmen also.
I feared to look upon the earth:
I entered and closed the door."

When the storm began the next morning, Ramman, the storm god, thundered in the heaven; the lightnings flashed; the waters rose. Even the gods were frightened. They took refuge in heaven, cowering like dogs. Six days and nights the winds raged and the rain fell. Then the sea was calm and the deluge ceased.

Ut-napishtim goes on to say:

"When the seventh day arrived,
I brought forth a dove, and let it go:
The dove went to and fro;
As there was no resting place, it turned back.

"I brought forth a swallow, and let it go:
The swallow went to and fro;
As there was no resting place, it turned back.

"I brought forth a raven, and let it go:
The raven went, and saw the decrease of the waters;
It ate, it waded, it croaked, it turned not back."

After this, Ut-napishtim leaves the ship and offers sacrifices to the gods. He says:

"The gods smelt the goodly savor;
The gods gathered like flies over the sacrifice."

Then Ut-napishtim and his wife, who had heretofore been only mortals, were given immortality, and were made "like unto the gods."

MOUNT TACOMA AND THE STORY OF EVE

The Indians of the northwest of the United States tell a story of the creation of the first woman that closely corresponds to the Bible story of the origin of Eve. The scene of this myth is laid on the slopes of Mount Tacoma at the head of Puget Sound in the State of Washington.

Thousands of years ago, when the world was very young, it happened that the waters of the Whulge or Puget Sound rose, overflowed their banks, and rushing over the surrounding country buried everything in sight. All living things perished save one man alone, who fled to Mount Tacoma in the hope of escaping the fury of the waves.

Higher and higher up the mountain went the man, and after him rose the waters till they were almost over his head and he was about to perish. Then it was that the Tamanouses, the guardian spirits of the mountain, came to his rescue. They turned the man into stone right where he stood. Soon after the floods began to subside, and the waters descended lower and lower till they finally disappeared and left the earth as dry as before. Then the Great Spirit, the all-ruling power of the Indians, took a rib out of the stone man and fashioned it into a woman. He then gave the breath of life to the man of stone and made him live again. Together now the man and woman descended to the valley, where they made their home and became the founders of the great Indian tribes of America, the first Americans.

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THE LAND OF THE MIDNIGHT SUN

Looking from Hjelle across quiet Stryns Lake to the steeps and glaciers of Mount Skaala, Norway.

HOW MAN GOT FIRE

It is always interesting to notice ways in which man is different from the animals. That we are different and very much higher in the order of creation is plain. But besides the big fact of superiority, there are several powers which we have and animals do not have that help to put us far above them. These outward differences are the ones which early peoples noticed and told stories to explain.

One of the most noticeable ways in which man differs from the animals is that he can make a fire. No other living creature ever builds a fire. The possession of this power adds so much to man's comfort and civilization that it is no wonder that every race and tribe has some myth telling how man got fire.

There are two kinds of stories. Fire was so wonderful that it must have been originally the property of the gods. How does one person get something which belongs to another? Either he steals it, or it is given to him. That was what must have happened in the case of fire. Either man stole it, or else it was the free gift of the gods. Most peoples thought it was stolen; and if you are curious to know why the gods should not want man to have fire and so should try to keep it from him, you will find out in these stories.

INDIAN SNOWSHOE DANCE AT THE OPENING OF WINTER HUNTING

HOW COYOTE AND THE ANIMALS HELPED THE INDIAN TO GET FIRE

In the olden days there was no fire on earth. Fire had been made, but it was hidden in a casket far, far to the north, and was kept by two ugly old women who never slept, day or night. Kareya, the world ruler, who had made fire, had put them there to guard it.

It was very cold on earth. Even the animals shivered in their warm coats of fur, and the poor Indian who had no covering except what he could make for himself was very unhappy. Coyote saw that the Indian must have fire to make him comfortable.

So Coyote called a council of all the animals,

from great roaring Lion down to Frog and little Mouse.

"Indian must have fire," he said, "and he cannot get it alone. We must help him. I think I can steal it from the old women, but they are swift of foot. The struggle will be to bring it back to our own country. Will you all help bring fire back?"

"We will," said Lion in his deep roaring voice.

"We will," sang Frog; and all the other animals joined in, saying, "We will."

So Coyote planned it all out that each animal should have his station along the road to the house of the old women, and each should be half a sun's distance from the other.

"The strongest and swiftest must be nearest their cabin," he said, "and each one must be ready to run swiftly when the firebrand comes to him. Indian will hide himself outside the cabin. I will go in. When I call him, he will make a rush and frighten the old women."

Coyote went to the little cabin and rapped on the door. One of the women came to the door; the other sat over the fire.

"Good evening," said Coyote.

"Good evening," said the old woman.

"It's a pretty cold night," said Coyote.

"Yes, it is," said the old woman.

"I hear you have a fire," said Coyote.

"Who told you that?" said she.

"Oh, everyone knows that," said Coyote; "and now will you let me come in and sit by your fire and warm myself? It is very cold out here."

"I suppose I must," said the woman crossly, and she opened the door the least bit wider for Coyote to slip in.

So Coyote went into the house, and lay down by the fire. Darkness fell, and Coyote pretended to go to sleep, but he kept one eye open watching for a chance to steal fire. Hour after hour he watched, but to no purpose. One old woman sat on one side of the fire, and the other sat opposite to her, and neither closed her eyes all night.

Next morning Coyote went out to find Indian. Poor Indian was almost frozen. He had been hiding all night behind a hill. Coyote told him that he must rush up to the cabin with a loud shout and attack it. While the old women were driving him away, Coyote would steal fire.

Coyote went back and sat down by the old women. Indian rushed up to the door and began to attack the cabin, shouting and yelling at the top of his voice. The old women were so alarmed that they rushed out to drive him off, forgetting all about Coyote, who snatched up a firebrand and ran off with it in his mouth. He had not gone far before they saw him and began to run after him. They were swift of foot, those ugly old women, and they gained on him fast. Just as he was getting beyond his strength, and was beginning to pant for breath and slacken his pace, he reached Lion.

Lion seized the brand from Coyote's mouth, and bounded off with it. The old women followed close. As Lion began to get weary he came to Elk's station. Elk ran like the wind, but the old women followed close behind. Then Fox seized the brand and carried it for a time; and so in turn all the animals kept up their flight, with the old women following on close behind.

At last the firebrand was brought to the edge of the cold country to Squirrel. He was next to the last in the line. As he seized the brand the old women almost caught up with him. He was so frightened that he dropped it, and in picking it up again his tail caught fire. Squirrel did not dare to stop. He ran right on, carrying the brand in his mouth; but he curled his tail up over his back, and it burned a spot right between his shoulders. To this very day you can see this spot on Squirrel's back.

Before long Squirrel came to Frog, and threw the firebrand into Frog's mouth. Poor Frog! he was not much of a runner, and he would have fared ill if he had not been near the river between the land of the Indian and of the animals, and the cold country of the old women. He hopped into the water with the firebrand in his mouth. But just as he reached the water one of the old women caught him and pulled his tail off. That is why tadpoles have no tails even to this day. The old woman thought she had got fire at last, but Frog swallowed the tiny spark and with a desperate wrench pulled himself away and escaped into the water. When he came to the other side he spat out the fire

on a piece of driftwood, where it sputtered and burned.

Poor Frog! He had saved fire for the Indian, but he had had the worst of it. Never since that day has his tail grown again. And the brand burned away one of his vocal chords, so that he no longer rivals the birds as he once did. This is why he dislikes fire, and even to this day keeps away from it.

But fire had been brought from the north. From that time fire has dwelt in the wood, and by rubbing two twigs together the Indian can always get enough to keep him warm. When he has got fire, some of the animals will come and sit around it with him; but others are afraid, for they remember what a terrible burning thing it was that they carried in their mouths.

HOW THE POLYNESIANS LEARNED THE SECRET OF COOKED FOOD

Away over the seas on the Polynesian islands, a long time ago, people did not know how to cook food, for they had no fire. Fire was only in the underworld, and even Maui, one of the guards of our upper world where mortals live, had never tasted cooked food, though his father and mother lived in the underworld, and he had been born there.

Every little while Maui's mother, Buaratanga, came from the underworld to visit her son; but she always ate alone from a basket which she had brought with her. One day while she slept Maui peeped into her basket and discovered cooked food. On tasting it, he found that it was far better than the raw food to which he was accustomed. Maui had heard of fire, and knew that this food must have been cooked by it. The secret of fire must therefore be in the underworld. Thither he would go and gain this knowledge, so that henceforth he might always enjoy the luxury of cooked food.

So Maui followed his mother secretly at a distance, and after some adventures succeeded in getting past the watchers at the entrance to the underworld. He went straight to his mother's house and told her that he had come to discover the secret of fire.

Buaratanga said: "This secret is kept by the Fire God Mauike. When I want to cook, I ask your father Bu to request Mauike to let him have a bit of burning wood."

Maui asked where the Fire God was. His mother pointed out the direction, and told him that the place was called "The House of the Banana Trees." As Maui started off, she called him back, and said: "Beware, Maui! be very careful, for the Fire God is a terrible fellow of a very irritable disposition."

Maui went fearlessly to the Fire God's house, guided by a column of smoke curling up. Mauike, who was busy cooking some food, stopped his work and asked what the stranger wanted.

"A firebrand," replied Maui.

Mauike gave it to him, and Maui went away with it. But as soon as he was out of Mauike's sight he took it to a river and quenched it in the water. Then he came back to Mauike and got a second firebrand. This also he took and quenched in the river. Still a third time he came back and asked for a brand. Then the Fire God was beside himself with rage. This was exactly what Maui wanted. He thought, quite rightly, that a firebrand would be of little use to him if he could not get at the secret of kindling a fire. The fire might go out, and how could he make fire again? Maui meant to pick a quarrel with the Fire God, and by getting the better of him to force him to reveal his precious secret.

The Fire God saw now that this impudent fellow wanted to get this wonderful knowledge which was known only to him. When Maui asked for fire the fourth time, he ordered him off, telling him that if he hung round there any longer he would toss him in the air.

"Perhaps two can play at that game," replied Maui. "Nothing would give me greater pleasure than to measure my strength with you."

Then Mauike rushed into his dwelling to buckle on his fighting belt. Maui was small of stature, and the Fire God thought he would make short work of driving this little fellow off. He rushed out from his tent, and grasping Maui in both hands hurled him as high as a cocoanut tree. Maui was crafty enough to make himself so light in falling that he was not the least hurt by the shock. Then the Fire God was very angry. Collecting his whole strength, he hurled Maui much higher than the tallest cocoanut tree

that ever grew. But Maui remained unhurt by the fall.

Now it was Maui's turn. Though he was small he was very strong. Seizing the Fire God, he threw him to a giddy height and then caught him like a ball with both hands. Without letting Mauike touch the ground, he tossed him a second time into the air and again caught him. So he kept him going until Mauike was dizzy and gasping for breath.

"Let me come down to earth, and spare my life," begged Mauike faintly, "and you shall have anything you want."

"Only on one condition will I spare you," said Maui; "reveal to me the secret of fire. Where does it lie concealed? How is it produced?"

"Only let me touch ground and I will tell you all," gasped Mauike.

So Maui let the Fire God touch the ground, and when he had recovered himself a bit Mauike led him into the inside of his wonderful dwelling. Here in one corner lay a heap of cocoanut fiber; in another, sticks of dry wood which lights easily, all kinds, but especially the banana. These sticks were all dry and ready for use. In the center of the room lay two other smaller sticks side by side. The Fire God gave one of these to Maui, bidding him hold it tight while he himself rubbed the other hard against it. As he rubbed the Fire God sang all the while:

"Give, O give me thine hidden fire,
Thou Banana tree!
Kindle a fire for Mauike
From these thy splinters,
Thou Banana tree!"

As the Fire God sang, Maui saw how from the fine dust made by the rubbing of one stick against the other a light smoke arose. As the rubbing continued, the smoke became stronger; and, fanned by the Fire God's breath, a slight flame broke out, which was kept up and increased by the fine cocoanut fiber. Then Mauike brought bundles of all kinds of inflammable sticks from his pile and put them over the smok-

PAPUAN FIRE MAKERS, FROM PHOTOGRAPHS TAKEN IN 1906

Both are rubbing the end of a stick against wood.

ing fiber, and soon, to Maui's astonishment, a bright flame blazed up.

The great secret of fire was secured. Maui returned from Spirit Land to the upper world carrying lighted firebrands in his hands, and better than that he knew the secret of how to make fire. The natives of Polynesia came to Maui and obtained firebrands which would light their fires and cook food for them. But after some time the fires went out, and they were unable to make more. Maui alone was never without fire in his home.

Then Maui took pity on the inhabitants of the upper world, and told them the wonderful secret that the fire was hidden in certain woods, and especially in the banana tree, and that this fire could be drawn out by using firesticks. Last of all he taught them the Fire God's song to the banana tree.

Since that day, says the Polynesian story, all the inhabitants of this upper world have successfully used the fire woods and enjoyed the luxury of light and of cooked food.

Some say that Maui brought more than fire to the upper world. They tell that it was all dark until he had gone down into the earth and wrestled with the Fire God and conquered him. As Maui made his way back, carrying the firebrands, their light shone ahead of him, throwing out red flames; and that was the first sunrise. Then he made his fire, and there was bright sunlight, and when it went out again it was night. But Maui could kindle it again, and he did, so that there was another sunrise. Another myth tells how Maui is still tossing the Fire God into the sky each morning, and catching him each night. How much of all this the story means, you may judge for yourself.

THE MAKING OF MAN BY PROMETHEUS

Among the most beautiful and most famous myths of the creation of man is the Greek story of Prometheus. In the earliest days, according to Greek mythology, there were wars in heaven. One rule succeeded another, as one set of gods won the victory and drove out the others. The greatest war of all was that between the Titans and Jupiter. Jupiter and his host held Mount Olympus and won, tossing the Titans down to earth and setting them at all kinds of tasks. It was after this war that Atlas was condemned to bear the whole world on his shoulders.

Prometheus was a Titan, but guided by divine wisdom he had taken the part of the Olympians, for it was shown to him that they were to be the rulers of the world. To him and his brother

JUPITER SURVEYING THE WORLD

Epimetheus was now given the task of making man and the animals, providing them with the powers necessary for them to be able to hold their own on the earth.

Epimetheus took the task of making the animals, and Prometheus was to create man. Epimetheus went to work at his animals and proceeded to bestow upon them all the gifts in his possession. To some he gave courage, to others strength, swiftness, sagacity; to one, wings, to another, fur, and to still another a scaly covering.

While Epimetheus worked, Prometheus took some earth and, kneading it with water, formed a nobler animal than any which his brother was making. He made man in the image of the gods. He gave him an upright stature, so that while other animals turn their gaze towards earth, man looks towards the heavens.

When the brothers were done they compared their work, and then it was seen that Epimetheus, always heedless and rash, had been so free with his gifts to other animals that no blessings were left which were worthy of being conferred upon his brother's creation, which was by far the noblest animal ever imagined. Man might have the powers of the animals in greater measure. He might be wiser than they, braver, more powerful; but no single blessing would be his alone.

Then Prometheus pondered as to what would make this man which he had formed the ruler

of the world. Man had become dear to his creator as he formed him, and now he was willing to risk anything to bring to this clay image which he had made the greatest blessing in the world.

So Prometheus ascended to heaven, lighted his torch at the chariot of the sun, and stealing fire brought it down to earth. Fire was a divine possession. Jupiter had never meant that it should leave heaven, for with it any animal would have too much power. With fire in his possession man could win from earth her secrets and her treasures, and develop commerce, science, and the arts. Not only did Prometheus bring fire to man, but he taught him how to use it, showing him all the useful arts.

Jupiter was very angry when he found out what Prometheus had done, and ordered that he be chained to a rock on Mount Caucasus, there to be subjected to torment by a vulture which should prey on his liver but never consume it. Here Prometheus hung for many ages, suffering for his goodness to man, until a hero from the race of men whom he had benefited, the mighty Hercules, came and freed him.

Many poets have told in beautiful verse the story of this Titan who gave himself for man, finding in it a symbol of the divine fire which is planted in every human breast and is strong to outlast all difficulties and dangers and come out victorious at the end. Perhaps the first which you will read is that of Longfellow:

> "Of Prometheus, how undaunted
> On Olympus' shining bastions
> His audacious foot he planted,
> Myths are told, and songs are chanted,
> Full of promptings and suggestions.
>
> "Beautiful is the tradition
> Of that flight through heavenly portals,
> The old classic superstition
> Of the theft and the transmission
> Of the fire of the Immortals!"

MAN AND HIS GIFTS

Fire is not the only gift bestowed upon man but not given to the lower animals. He is the only animal that uses tools. No other living creature works with, much less makes, a tool. Animals have tools in their bodies which they employ skillfully; claws to hold things, snouts to dig with, and a hundred other implements, large and small, adapted to their needs. But man has not only the most wonderful body in the whole range of creation; he has also a brain which tells him how to use his body in fashioning helpful tools with which he may reach out and conquer the world. His bare hands could not reach far or do heavy tasks, but they can make machines which will do him every service. Nor should we seem to make little of the human hand. It is a wonderfully delicate and skillful servant, as well fitted for man's needs as is every other part of his body. It is said that only men and monkeys have thumbs. Men's thumbs are better placed and more flexible than monkeys', and it is this which gives their hands such skill in carrying out the orders of the brain. Men's chins and foreheads are also much more developed than those of any lower animals.

Man is the talking animal. Other creatures may communicate with each other, but only members of the human family talk an articulate language and can learn languages other than their own. They are the only ones, too, who can write and read writing. Out of these two gifts grow society, which is the intercourse between man and man; and history, which is the recording by one generation of its story for another generation to read. To-day archæologists are digging up in Crete and Greece and Egypt and all over the world records which were made by people who lived six and eight and ten thousand years ago.

On us has been bestowed the gift of curiosity, which gets us into many troubles but brings us many blessings. From our curiosity comes our interest in invention, which leads us from one mechanical triumph to another. We long to explore the world, to search out its hidden treasures, to study into the processes of life. And we are the only creatures in God's world who are religious. The divine life in us, which every myth explains by saying that we were formed by the Creator in his own image, has not only put us at the top of the brute creation, but has made us turn towards a higher power.

The true story of how man has used all these many gifts, and how he has come down the long road of civilization, is even more wonderful than the myths of how these powers and gifts came to him.

STONE AGE SCULPTOR, OR PALEOLITHIC MAN, AT WORK ON A DAGGER

A. Forestier, Special Artist of the "Illustrated London News," says of this drawing that the man shown is of the Cromagnon race. These tall, strong, intelligent men not only painted and engraved, but practiced bone and ivory carving. They resembled some American Indians.

THE STORY OF HUMAN BEGINNINGS

SOME OF THE PUZZLING QUESTIONS ABOUT OUR HUMAN RACE

"The proper study of mankind is man." — POPE.

WHERE WAS THE FIRST MAN BORN AND WHEN?

THIS is the question of the ages, but the only answer is that nobody knows. It is one of the strangest things in the human story that although man has been living on the earth for ages, no one can tell exactly how long, or date even the century of the Year One of Humanity. Nor does anybody know for certain where the first human being saw the light. Some say Asia, some Egypt, some Europe, some the island of Java, but nobody knows. The Book of Genesis, the most interesting as well as the most venerated of ancient histories, tells us of a first man in that wonderful story of creation; we read of the beginning of the human line, of historic man, man already endowed with understanding, who talked with his Creator, named the animal creation, tilled the soil, and started family life and history. Even he had no date more definite than "in the beginning." Reread that account of the "days of creation," the most brief and clear summary of epochal events ever written, and keep it in mind as you read the parallel story of science as it has been worked out in recent years.

HOW SCIENCE TELLS THE STORY

When the scientist begins to study a question, he examines what he can see, what he can find, the evidence that lies about him. Science begins its story of man in the rocks. There he finds buried, along with animal bones, the bones of early man, or fragments of them. From the traces of life which the earth holds hidden within itself, deep down in caves or high on mountain tops, the geologist begins his story of early man.

If you have read "The Earth a Storybook" — and if not, you should at once turn back and do so, in order to understand about the geological epochs, such as the Tertiary and Quaternary and Pleistocene, which will soon be mentioned — you will remember that there are layers of rock which it took epochs of millions of years to form; and that when skeletons of once living animals, like the mastodons in our museums, were found in these under layers,

it was proof that the animals lived in a certain geological period. In the same way, when bones of a human skeleton are found in rock strata, or layers, of the Glacial (Ice) Age, it indicates that a human being of some kind lived in that period. But it does not tell the year, for these geological epochs disdain such small periods of time as years. A million years is with them as one day.

We live in a time when men are busy in digging into everything in sight or out of sight, and as a result of ceaseless exploration and excavation new discoveries occasionally throw some light on man's probable starting time and place, and his wanderings to and fro in the earth; but there are no fixed dates, such as that of the discovery of America by Columbus, to be committed to memory by boys and girls; and very likely inquisitive people in the thirtieth or fiftieth century will be asking the same questions about man's beginnings that we of the twentieth century ask. We shall give some of the theories, or clever guesses, and you can accept or reject them. It is a part of wisdom and of education to know what the learned students of these great subjects — the ethnologists and anthropologists and ethnographists and geologists and psychologists and zoölogists and philologists, and any other "gists" that we have accidentally omitted — have to say.

SOME OF THE LONG WORDS EXPLAINED

And in reading or studying about these interesting things — for nothing can well be more interesting than the study of man — we should know the meaning of words that must be used. To save you the trouble of going to a dictionary we give some of them here. Anthropology (Greek *anthropos*, man, and *logos*, science) treats of man in general and his relation to the animal kingdom, of which he is the head and the highest species. Ethnology (*ethnos*, race, and *logos*) is a branch of Anthropology, dealing with man's origin, antiquity, migrations, physical and psychical characters, and his division into races and groups. Ethnography (*ethnos*, race, and *graph-y*, writing) goes further into the details of the race about which Ethnology tells, and traces the life of the subdivisions and peoples and their relations to each other. Zoölogy and Geology have been defined elsewhere. Physiology tells about the body, and Psychology about the soul, of man. Psychical (Greek *psukos*, soul) is a word much in use at present, as "that was the psychological moment." Primal man, or primeval man, is just the first man. Prototype is first type or form (Greek *protos*, meaning "first" in whatever connection you find it, as Latin *primus* does). Primordial (first order or type) is the adjective, prototype the noun, expressing the same idea. You can dig history out of words just as you can out of rocks.

TERMS FREQUENTLY USED IN THE STUDY OF THE HUMAN SPECIES

A few more definitions will help us in the study of man. A *Race* is a variety or subspecies of the species Man, presenting a number of distinct and permanent traits. A *Branch* is a portion of a race separated from other portions by distance, language, or otherwise. *Peoples* are a portion of a branch united by some prominent trait, especially language. A *Group* consists of a number of Peoples closely connected by location, language, and physical traits. A *Tribe* is a body of men collected under one government, presumably of the same race and speech. A *Nation* is a body of men under one government, but frequently of different languages and races. An *Ethnos* is a people, forming one element of a stock all of whose members have a clear relationship. Thus the Aryan stock is made up of the Latin, Greek, and other peoples.

SOME FURTHER QUESTIONS

There are various other things we wish to know. Is there more than one human species? How many races of men are there? What is the difference between species and races? What do we mean by tribe, people, nation? What is an ethnic group, and how are such groups distinguished? Why are some men black and some white? How did the first folks begin to make themselves understood? How did language grow? Who invented writing? How did the first men live?

Courtesy of American Museum of Natural History, New York

SKELETON OF COLUMBIAN MAMMOTH

These are some of the puzzling questions which we are to consider. The first is whether there is more than one human species or kind.

DID ALL MEN COME FROM ONE FAMILY STOCK?

Modern scholars are pretty well agreed in saying yes to that. They join with the German ethnographist Ratzel, who says in his great work, "The History of Mankind," now out of print: "Wherever the earth is habitable by man, we find peoples who are members of one and the same human race. The unity of the human genus is as it were the work of the planet Earth, stamped on the highest step of creation therein. There is only one species of man; the variations are numerous, but do not go deep. Man is in the widest sense a citizen of the earth."

But this is easier to say than to believe, at first, when one thinks of the many striking differences to be seen in the various human groups scattered over the world — the black, yellow, brown, red, and white; the woolly-headed and straight-haired; the tall and short, savage and cultured. We ask instinctively, Can all these be of one stock, or are they of many? Is the African of the same family as the Scotchman? Do all the races trace back to the one common ancestor, or are there four races at least, with uncrossable gulfs between them?

WHAT SOME OTHER EXPERTS SAY

Let us have answers from some other modern scholars. Dr. A. H. Keane, an English writer, in his book on "The World's Peoples," says: "The answer given by those most competent to judge is that the various divisions of mankind are really blood relations, branches of one parent stem, members of a single human family, which had its rise in one primeval home, and spread thence by slow migratory movements over the globe." He finds one proof of this in the fact that the varieties of dogs, which are admittedly sprung from one ancestor, differ one from the other far more than do the human varieties. A huge mastiff might make a mouthful of a mercurial toy terrier, whereas a tall Scot is less than twice as tall as the smallest African Pygmy. Then, the human varieties all merge gradually one in the other through imperceptible transitions, as between Finn, Lapp, and Tartar; Bushman, Hottentot, and Herero; Melanesian, Micronesian, and Polynesian; Japanese, Korean, and Mongol; Uzbeg, Turk, and European; and so on. This alone would show that we are dealing, not with specific differences, but with mere varieties, all sprung from a common human prototype.

An American authority, Dr. Daniel G. Brinton, after giving his belief in the unity of the human race, says: "It seems to me that anyone who will study the similarities of growth in the arts and sciences, in poetry and objects of utility, throughout the various races of men, cannot doubt of their psychical (soul) identity. Still more, if he will acquaint himself with the modern science of folk-lore, and will note how the very same tales, customs, proverbs, superstitions, games, habits, and so on, recur spontaneously in tribes severed by thousands of miles, he will not think it possible that creatures so wholly identical could have been produced by independent lines of evolution."

So modern experts, however they may differ on other lines, agree that there is one human species, with a common parentage, just as the Scripture story has it.

WHERE DOES SCIENCE FIND THE FIRST TRACES OF HUMAN LIFE?

If we were going to search for man's birthplace, it would seem to be common sense to look for it where the oldest relics of man or his industries have been found, where the climate was suited to his unprotected state, and where the general conditions were most favorable. We have been taught by long tradition to look for the first home "somewhere in Asia," as Professor Max Müller generously expresses it. But Dr. Brinton points out the important fact that the oldest remains of man's arts, the first rude flints which he shaped into utensils and weapons, have not been discovered in Asia or in northern Europe. They have been dug up in the late tertiary or early quaternary (look this up in the geological chart on page 69) deposits of

DIPLODOCI, CHEERFUL ANIMALS FOR THE FIRST MAN TO MEET AFTER DARK

southern England, France, Spain, and the valleys of the Atlas in northern Africa. They have been hunted for in vain in Scandinavia, Germany, Russia, Siberia, and Canada. None of the older types of paleolithic (stone) implements have been reported in early deposits in those countries. But in the "river drift" of the Thames in England, the Somme and Garonne in France, and the Tagus in Spain, quantities of rough stone implements have been disinterred, proving that in a remote epoch, when the hippopotamus and rhinoceros, the African elephant and the extinct apes found a congenial home near the present sites of London, Paris, and Lisbon, primeval man was also there.

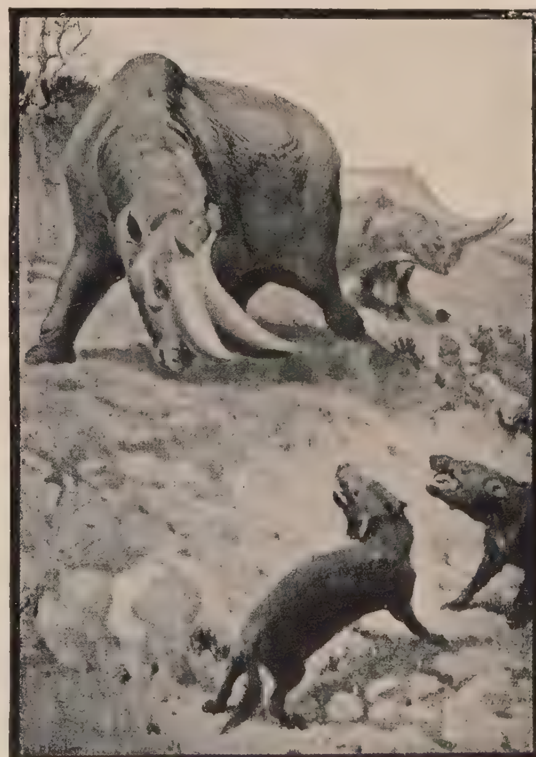
These relics are the very oldest proofs of the presence of man on the earth.

In the very same region we find the remains of the highest of the lower animals. It is in the valleys of the Garonne, in southern France, that the anthropoid ape, which comes closest to the human form, has been disinterred. Its height was about that of a man, its teeth strongly resembled those of the Australians, and its food was chiefly vegetables and fruits. At that time also, as the vegetable and animal remains show, the climate of southern Europe and northern Africa was singularly mild and even. So that here we have all the conditions for man's beginning under favorable circumstances. As there was probably a land connection between northern Africa and southern France at that time, the start might have been made in either.

Dr. Keane thinks the human cradle may be located with some certainty in the Eastern Archipelago, and more particularly in the island of Java, where in 1892 Dr. Eugene Dubois brought to light the earliest known remains that can be described as distinctly human. Others locate the first signs of human life in the Nile Valley, declaring that the Pygmies were "the first or primitive men—the little earth men—from whom all others sprang and first peopled the world. With them language originated, and the first sacred ceremonies." All these regions had similar climatic conditions.

WHAT COLD WEATHER DID FOR MAN

Gradually a wonderful change took place in the conditions of prehistoric human life. Picture the transformation from a semi-tropical



THE PREHISTORIC ANIMALS
This is the type of roaming rhinoceros that early man may have met in the wild.

climate to a world of ice. Mighty masses of ice, thousands of feet in thickness, gathered around the poles, and collected on the slopes of the northern mountains. Then with irresistible might they advanced over the land and the sea, crushing beneath them all animal and vegetable life, changing the African summer to Arctic winter. The tropical animals fled or were frozen, the plants perished, and under the enormous weight of the ice the ocean bottom in the north was pressed down a thousand feet or more. The bed of the Mediterranean sank to its present level, and the map makers, had there been any, would have had to make new ones, showing many changes. Before this vast ice wave man retreated, forced southward by the cold, as was the most of living creation; but when the ice crust receded he came back, undaunted by the cold. As always in human history, danger and difficulty stimulated him and spurred him on to new endeavors. Still, in the low stages of life, he had no knowledge of metal, did not even seem to know how to polish stones, had no domestic animals, and did not cultivate the soil. Yet he had some skill as a workman, and took some steps towards civilization. For example, he learned the use of fire and began to form a society. This was a decided advance. Now the people dwelt together in companies, found some sort of shelter, ate animal as well as vegetable food, and made rude floats for use on the streams. As a protection against the cold they made cloaks of skins for clothing. Pride was not wanting, for they made crude ornaments, and used colored clay for painting themselves on occasion. The strange part of it is that these facts have become known through study of the tools and implements they left to tell their story ages after they had passed away. It remained for highly civilized man to search out the hidden places, to read the rocks, to unbury the proofs of the kind of men who lived ages ago, and the kind of life they lived. That study is still going on.

IMPLEMENTS OF THE OLD AND NEW STONE AGES

This is the first stone cutting and carving done by man, long before history began.

ASTONISHING SIMILARITIES

A common descent and separate local developments of different branches of the human family explain the striking likeness everywhere presented by the earliest remains and the earliest works of primitive man. Such are the fossil skulls found in Europe, Egypt, Mongolia, and America, and the stone implements found in vast quantities in Britain, France, North and South Africa, India, North and South America. Rude stone implements brought from the most distant lands are so alike in form and character that they might have been formed by the same hands. On the banks of the Nile objects of European type have been discovered, and others collected in Somaliland, South Africa, might have been dug out of the drift deposits of the Seine or the Thames. The geologic epoch (the Pleistocene or Quaternary epoch) in which these proofs of man's

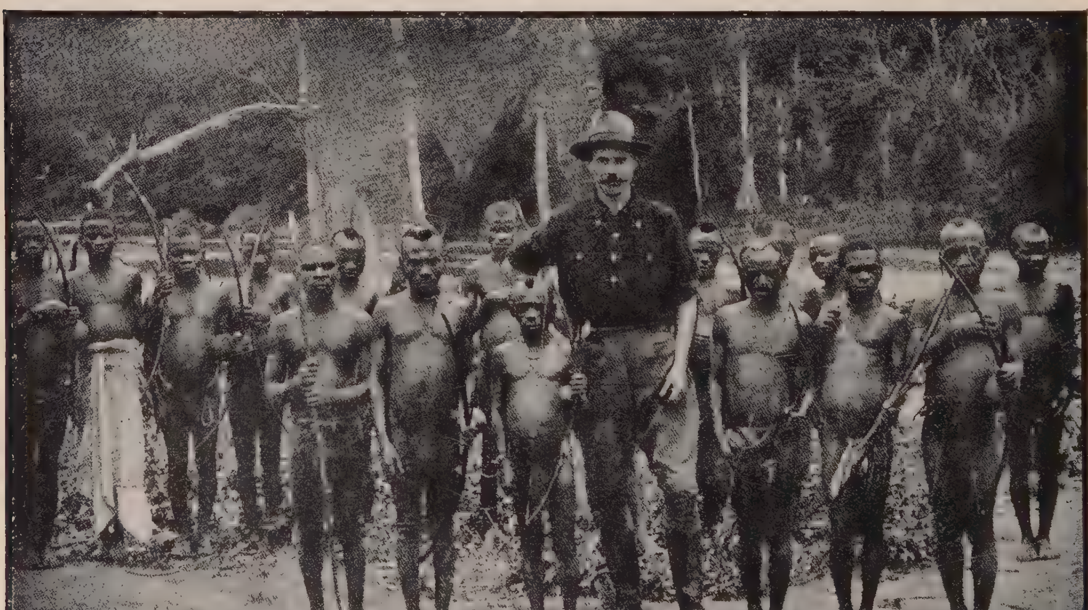
THE FARNESE BULL

Contrast this sculptural marble, one of the finest products of human genius, with the first stone carving of Prehistoric Man; or contrast the Cave Drawings on another page with the work of the great artists of civilization, and you can see the distance man has traveled in artistic development. This group is by the Greek sculptors Apollonius and Tauriscus, and is in the Naples Museum. Its legend is that Antiope, a slave of Dirce, was to be bound to the horns of a wild bull by order of her mistress. Antiope fled to her sons, who seized Dirce herself and bound her to the bull.

SAVAGE ISLAND BOAT, WITH OUTRIGGER

The ingenious device of the outrigger was early introduced, by which the long, narrow boats, dug out of tree-trunks or made of bark or reeds, are kept upright.

first rude handiwork are found, covered a vast period of time which has been divided for convenience into the Paleolithic or Old Stone, and the Neolithic or New Stone Age. In the Old Stone Age, which was much the longer, the stone was at first merely chipped, flaked, or otherwise rudely fashioned; but in the New Stone Age it was more carefully worked and polished, showing an advance in artistic sense as well as ideas. In southern France there must have been quite a "Stone School of Art," for here were produced some remarkable stone, horn, and even ivory scrapers, gravers, harpoons, ornaments, and statuettes with carvings on the round, and skillful etchings of seals, fishes, reindeer, harnessed horses, mammoths, snakes, and man himself, all showing careful, artistic workmanship.



PYGMIES OF THE AFRICAN FOREST, SUPPOSEDLY PRIMITIVE MEN, CONTRASTED WITH A SIX-FOOT WHITE MAN

CEREMONIAL MASKS FROM NEW IRELAND, ONE-EIGHTH OF REAL SIZE

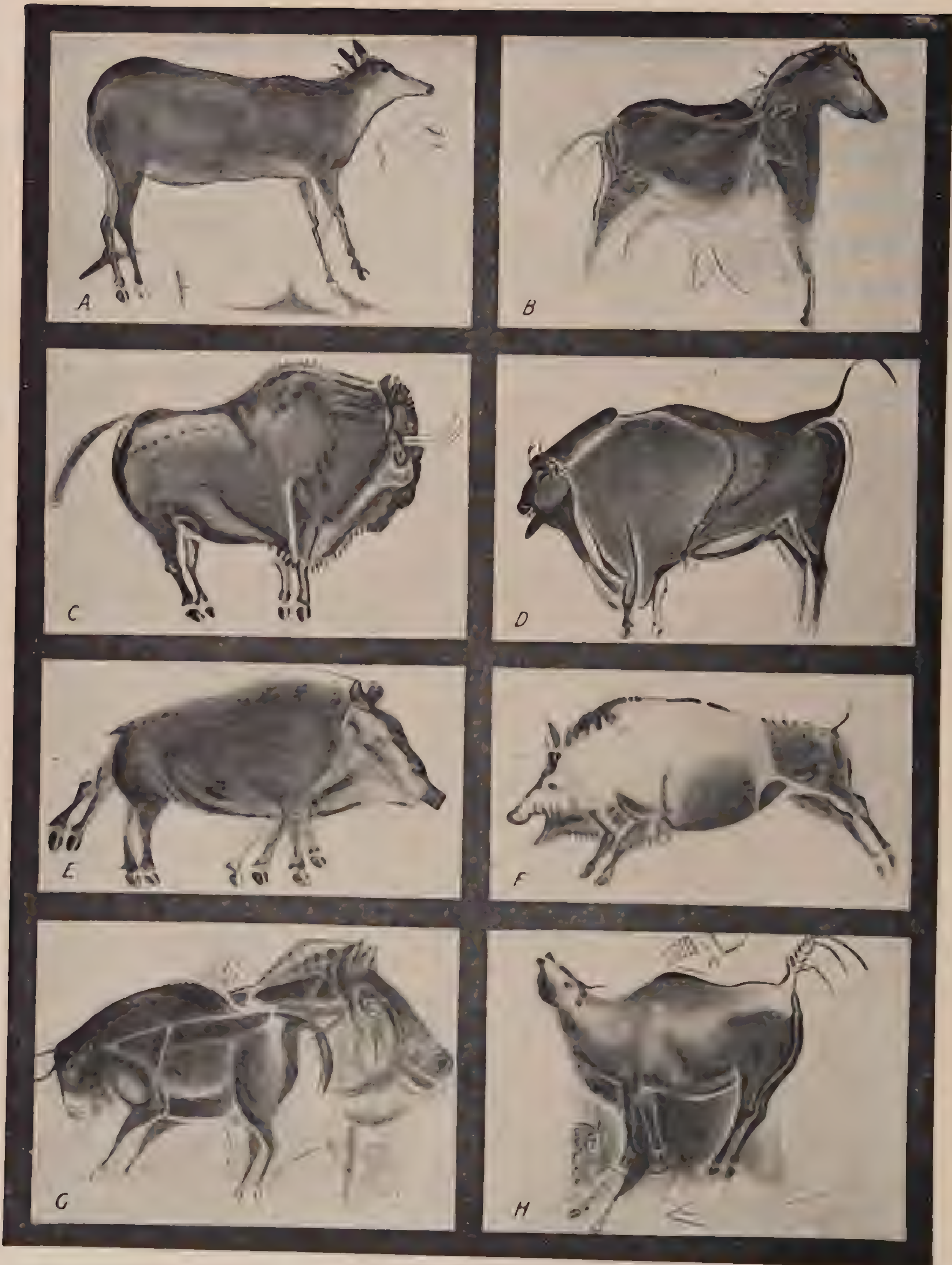
HISTORIC AND PREHISTORIC

The story of the "Ancient World," of Greek, Roman, Hebrew, Babylonian, and Egyptian civilization, has been preserved to us not only in stone, clay, and other tangible "remains," but also in inscriptions and on parchments which constitute a written historical record. Because of this written record, such periods are called historic; back of that come the prehistoric ages, for which we must depend solely on "remains" which have survived the passage of centuries. In the United States and Canada we are familiar with the relics of Indian and earlier occupations of the country. Such are the flints and arrowheads which many a boy has found near river beds or in uninhabited regions near his home. On pages 353 and 358 of this volume are pictures of temples in Yucatan and cliff dwellings in New Mexico, while on page 354 is given a brief account of the remains left by prehistoric mound builders of the Mississippi valley. They are mentioned here only to bring home to us the fact that such French and Spanish discoveries as we are about to describe are not foreign and remote, but parallel to similar traces of prehistoric life in our own country. As the written records of Greece, Rome, and Egypt would have been barren without the art treasures which had been kept for centuries under a shallow coating of earth, so our knowledge of prehistoric times would have suffered untold loss if it had not been for the preservation in various parts of the world of the art and handicraft of this early race, or, as the archæologists prefer to put it, these early races. As from the finds in the buried city of Pompeii archæologists have been able to reconstruct in a measure the life of the people of that ancient city, so from recent discoveries they are beginning to picture to us the men who dwelt on our continents in prehistoric times.

A WONDERFUL DISCOVERY BY A CHILD

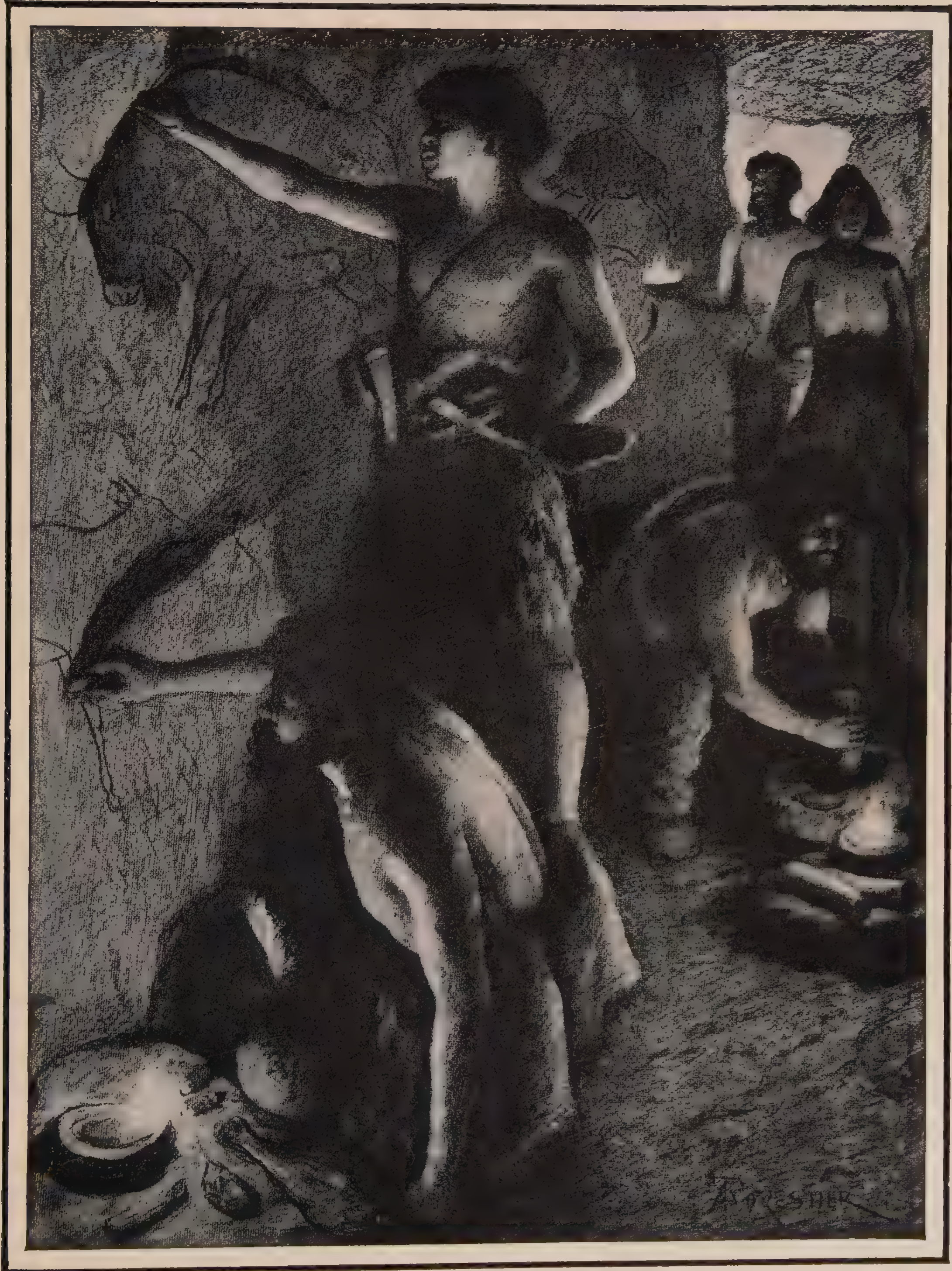
All through southern France and Spain the limestone formation of the country has lent itself during various periods in geologic development to the creation of vast underground caves, caverns, and grottoes. Subterranean streams wearing through the soft rock left chambers of great depth which in earlier periods were evidently easily accessible to the outer world. Investigation of the contents of such caves has been going on for many years, the usual discoveries being flints, stones, tools, burial piles and all the other practical paraphernalia of life familiar to every student of archæology. A Spanish nobleman by the name of Sautuola, an archæologist, was greatly impressed at the Paris International Exhibition of 1878 with the prehistoric collections of such finds made up from newly opened caves in southern France. Returning to his home he began to explore certain caves near his estate. From his exploration comes one of the most important discoveries of modern times, as well as a most charming incident in the annals of archæological research.

Sautuola's little daughter accompanied him on some of these exploring trips. One day while her father was searching on the floor of a cavern among the usual archæological débris, she wearied of the slow business and began looking about. "A bull," she cried suddenly, pointing to the roof of the cave. At first her father did not heed, but as she persisted, he lifted his lamp



STONE AGE DRAWINGS ON THE WALLS OF ALTAMIRA CAVE

These drawings disclose the artistic instinct in man from the beginning. They are in every way interesting. Note how one animal is superimposed upon another, and how skillfully the form and features are delineated.



ARTIST CAVE MEN OF THE STONE AGE

They drew these remarkable pictures from twenty to thirty thousand years ago. The originals are in the Altamira Cave, at Santillane, Spain, and are reproduced by the "Illustrated London News" from colored drawings of them made by Henri Breuil, and published in "La Caverne d'Altamira."

to look at the ceiling. There he saw the famous Altamira paintings, of a few of which we have been able to make reproductions on page 284, the roof of the cave being overlaid with drawings of a crowd of figures faithfully representing bulls, horses, deer, some of them lifesize, in a great variety of movements and attitudes.

THE ALTAMIRA DRAWINGS AND THE ARTISTS WHO MADE THEM

Our own reproductions are in black and white, but the originals are in soft red and yellow tints. Study of them has revealed much concerning the men who did them. Before we consider these results, let us study the drawings we have been able to reproduce. Some are quite distinct, others are overlaid one on another, probably representing long intervals of time. Beginning at the top of the page, the first figure (A) is of a hind, a small sketch of a bison showing at the right. The drawing from which this was taken is nearly three yards long. Next (B) is a horse, quite like our own horses, painted over an earlier sketch, still very distinct, of a small hind. The bison (C and D) is one of the best preserved and most vivid and lifelike of any of the hundreds of drawings since found in France or Spain. It shows not only artistic sense and skill, but a careful study of anatomy and considerable ability in perspective and the representation of action. An artist began in the next panel (E) to draw a galloping beast; he or some other artist finished with the same animal walking, but in the opposite panel (F) a complete picture of a galloping boar is undisturbed. On the bottom line (G and H) are curious effects of superposition, an ox at the left with a boar, and peering over the two a horse's head, and at the right an animal lowing.

Since this discovery similar finds have been made in other caverns in France and Spain, till there is revealed a school of art extending over a considerable area. Think for a moment of the wonder of the preservation of these sketches. Now in the nineteenth and twentieth centuries of the Christian era modern men dig away the rock formations which have obstructed for untold centuries the entrances to these wonderful caverns, and stand suddenly in the presence of handicraft of artists of real genius who lived in remote ages, men who entered these caves, probably with religious as well as artistic impulse, painted on the walls their beautiful delineations of the life about them, and passed on with their generation, never dreaming of others who so many hundred years later would suddenly come upon these tokens of their life and find in them a link of common artistry and common humanity.

The value of such discoveries in the study of animal life in the various periods is easily seen. Throughout the caves and rock shelters of the world skeletons of animals, and to a lesser degree of men and women, have been found. It is from these skeletons that the drawings of prehistoric animals which are shown in these volumes have been constructed. Here it is possible to study the types of horse of different periods, the wild cattle, and even the mammoths which have not survived to our day. Parallel to these discoveries has been the uncovering of similar sculpture on the roofs and sides of caves, which give even further details of animal life of each period.

From the skeletons and remains it has been possible to reconstruct vivid pictures of these artist cavemen and hunters, of which two of the most realistic are given, the one on page 285, facing the drawings and showing how these men must have looked as they mixed their four colors and applied them to the sketched outlines, the other on page 274 of the sculptor at his work. To modern artisans the wonder is that men had the infinite patience to create with crude tools models of such fine workmanship and artistry.

THE MENTAL POWERS OF EARLY MAN

Of the archæological conclusions concerning this early life, we cannot do better than to quote the summary with which Dr. Henry Fairfield Osborn concludes his study of "Men of the Old Stone Age." "During this dawning period of the long prehistory of Europe the dominant features are the very great antiquity of the spirit of man and the fundamental similarity between the great steps of prehistory and of history. . . . During this age the rudiments of all the modern economic powers of man were developed: the guidance of the hand by the mind, manifested in his creative industry; his inventive

faculty; the currency or spread of his inventions; the adaptation of means to ends in utensils, in weapons, and in clothing. The same is true of the æsthetic powers, of close observation, of the sense of form, of proportion, of symmetry, the appreciation of beauty of animal form and the beauty of line, color, and form in modelling and sculpture. . . . The religious sense, the appreciation of some power or powers behind the great phenomena of nature, is evidenced in the reverence for the dead, in burials apparently related to notions of a future existence of the dead, and especially in the mysteries of the art of the caverns. All these steps indicate the possession of certain *generic* faculties of mind similar to our own. That this mind . . . was of a kind capable of a high degree of education we entertain no doubt whatever because of the very advanced order of brain which is developed in the higher members of these ancient races. . . . The emergence of such a mind from the mode of life of the Old Stone Age is one of the greatest mysteries of psychology and of history."

OUR HERITAGE

Such is the verdict of a great scientist concerning prehistoric man. With dates and periods the average reader can have nothing to do. The remains are at our doorsteps. The men whom they represent lived at some period before the preservation of written records. But to the average reader who has been disturbed by generalizations of science concerning the similarity between man and the higher animals, which did not meet his practical judgment nor harmonize with his religious belief, it is of overwhelming interest to see how the cycle has been rounded out, and the evidence of modern scientific discovery swings back to the first and last word of religion: "And God said, Let us make man in our own image, after our likeness: . . . So God created man in his own image, in the image of God created he him." The man who left his record on the cave walls and ceilings of Europe, in the cliff dwellings of New Mexico, and the mounds of the Mississippi valley, long before the human race came to the thought of a historical written record, was not like the beasts, savage and inhuman, but was marvelously like unto ourselves in mental and spiritual powers. It is worth all the years of study, all the painstaking effort, to have science, taking nothing for granted but building up its structure of knowledge bit by bit from the evidences hidden in the earth, become in this inspiring essential of human faith the handmaid of religion. We may listen to the hypotheses of periods and times and seasons, and to all the interesting theories concerning these remains, taking what seems to us reasonable, but knowing that these are details on which for generations to come there will be investigation and discussion. The God-given supremacy of man "made in His image" is our heritage. It is for each generation to take its part in bringing the human race nearer to its goal.

PREHISTORIC ANIMALS

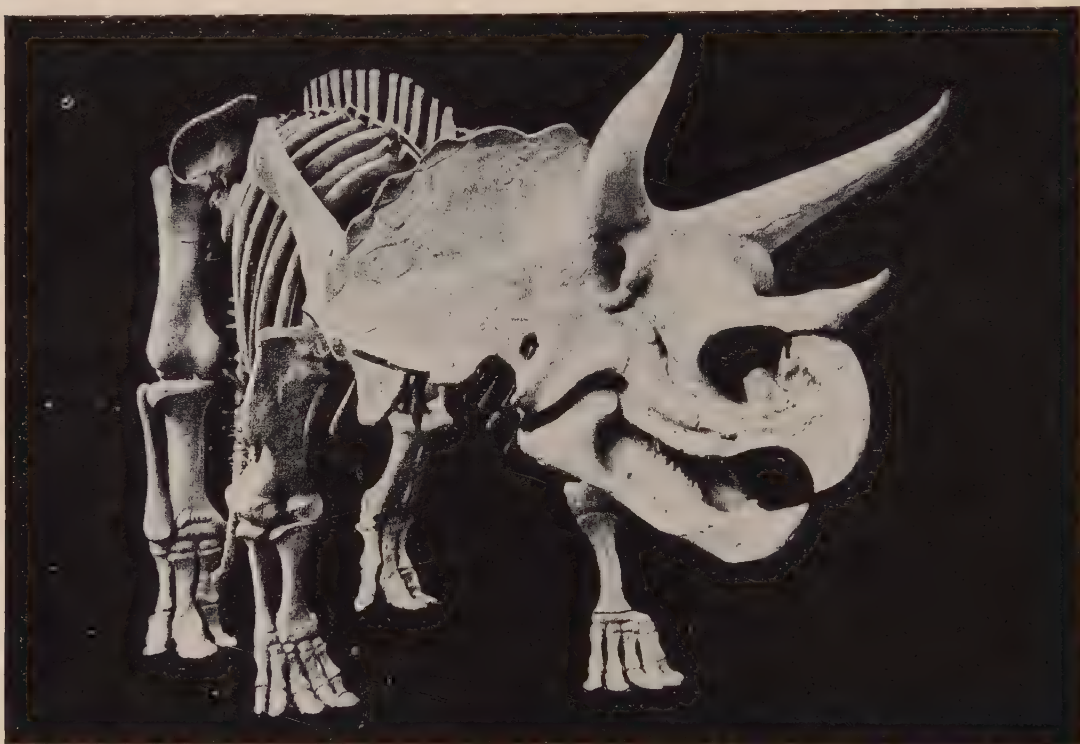
The animals pictured on the walls of the Altamira cave are comparatively familiar to us. It requires no stretch of imagination to picture the hunter artists of those early days in close contact and association with them. Quite the opposite is our feeling concerning the mammoth creatures with which modern archæology has peopled the land and water of certain prehistoric periods. Yet no story of human beginnings would be complete without a reference to these formidable inhabitants of the earth.

That such animals as the diplodocus and the plesiosaurus lived, skeletons found in our own North American continent testify. The scenes represented in prehistoric "reconstruction pictures" are as likely to have taken place in our own backyards as across the seas. Turn to the pages of early animals in the Nature Book. The herbivorous animals shown (Volume Three, page 152) had their habitat in "the flood-plains and lagoons of the region now elevated into the Rocky Mountain chain of Wyoming and Colorado"; the armored creatures on the opposite page made themselves at home in Texas and possibly as far East as the Connecticut Valley.

THE VICTORY OF BRAINS OVER BRUTE FORCE

With minute brain capacity, the weight of the brain estimated as sometimes less than 1/4000 of the body weight, these strange beasts combined excessive mechanical power. As engines of destruction they were tremendously

powerful. Whether man had ever to meet them, or whether these awkward giants had in large measure disappeared from the earth before his advent, we do not know. Had he met them, the brain capacity with which he was so richly endowed would doubtless have made him more than a master for them. The chapter of animal progression which they make up seems like an adventure in the huge laboratory of Nature, an adventure in which brains and skill were pitted against size and brute force. The survival of smaller, more adaptable creatures gives the key to Nature's method.



THE SKELETON OF A TRICERATOPS

The skull in some of these members of the Dinosaur family was seven feet long.

HOW CAME THE SEPARATION INTO RACES?

Now we come to one of the most puzzling questions, how mankind from one original became divided into such distinct and marked varieties. Why is one race white and another black and another yellow? How did the one species split up into sub-species, and when? Modern ethnologists believe that the human family remained practically the same in all essential elements until long after the beginning of the migrations that settled him in all parts of the world. "Restless movement," says Ratzel, "is the stamp of mankind." The pushing out into new sections, or pioneering, seems to be a habit as old as the race itself. After the first colonies of Pleistocene pilgrims had settled in their chosen localities, under the influence of changed climate and conditions, they began to change in color and characteristics. Just how the color of one division became black, and that of another white, has not been satisfactorily explained, but the fact remains. Nor do we know how one group came to develop larger brain power and so make greater progress than another, but we know that it did, because we have the history of Africa and Europe and America to tell us. It used to be thought that the present varieties sprang from one another; that an originally black group, migrating from one continent

THE LAST TASMANIAN MAN

WOODEN TUREEN AND SPOON FROM LUZON

THE LAST TASMANIAN WOMAN

The Tasmanian race disappeared when William Lanney and his wife Truganina died at a very advanced age. This was an old race, reaching back to prehistoric times.

to another, became white in Europe, yellow in China, brown in India, and red in America. The latest theory is that the four main divisions or races were evolved independently in their several zones or dwelling places from four ancestral groups, which in turn sprang from a common parent type, for which we must look back to the Pliocene epoch. As to how these four groups split off, and how they got to their zones, we can only imagine.

THE FOUR MAIN RACES

There are difficulties, of course, but not so great in explaining this as other theories. All that we certainly know about it is this: that long before the dawn of history, back in the dim epochs of which geology tells, when the earth was still taking shape, and all sorts of strange and huge animals were roaming the land and swimming in the seas, First Man appeared and human life began its marvelous career. This human family, which originated in southern France, let us suppose, grew rapidly and gradually dispersed over the earth. We now find mankind, grown to fifteen hundred millions, represented in different parts of the world by four main varieties or sub-species, with their twenty-nine races and endless sub-races, their varied colors and shades of colors, their diverse languages and customs. The four main races, and the regions they chiefly inhabit, are as follows:

Negroes, or Blacks, whose ancestral home is in the Soudan, South Africa, and Oceania (Australasia).

Mongol, or Yellow, found in Central, North, and East Asia, including the vast population of China and the Japanese.

Amerinds, or Red and Brown, a new name for the American Indians and other aboriginals of North and South America.

Caucasians, whites of all shades, in Europe, America, North Africa, Irania, India, Western Asia, and Polynesia.

WHAT MIGHT HAVE HAPPENED

Set up a yellow Chinaman, with his slanting eyes, a black Negro, with his thick lips and woolly hair, and a red Indian, with his aquiline nose and straight black hair, beside a blonde or brunette German, Englishman, or American, and try to imagine that they all belong to the same family, and came from the same great-great-grandparents. It seems impossible, go as far back as you will; but as great differences as these may have come about in a long enough course of time, and if the scholars are right, there were many thousands of years for just such changes to work themselves out. There was a period of many, many thousand years between the close of the Ice Age and the beginning of recorded history. The races were distinct more than six thousand years ago,

and the racial traits of the black, the white, and the yellow divisions were as pronounced then as now. These fundamental racial characters are believed to be the result chiefly of climate, soil, diet, heredity, and time. The subdivisions are what would be expected from the mixing of different bloods, as people of one race intermarried with those of another. Perhaps the mightiest cause in the change of types is intermarriage between races. This has taken place from distantly remote epochs, especially along the lines where two races come into contact.

HOW THE RACES DIFFER

Why is it thought strange that races should differ so greatly, when no two persons of the same family are exactly alike in features or disposition or complexion? In the same family you can find blondes and brunettes, snub nose and Roman nose, blue eyes and gray, black hair and red or yellow, strong and weak physique, tall and short stature, lean and fleshy bodies, lovable and ugly dispositions. Is it strange if races should differ even more widely?

Races differ in skull measurements. There are the long skulls (dolicho-cephalic) and the short skulls (brachy-cephalic), and the in-betweens. The Asiatic races (Chinese and Japanese) are generally long skulled, the African negroes and Eskimos are short or broad; while the whites and the American Indians present great diversity. In our race there are all sorts of skulls, long and short, thick and thin, and medium (meso-cephalic).

Races differ also in the orbit of the eyes, in the aperture of the nostrils, in the projection of the upper and lower jaws beyond the line of the face, in the teeth, and in brain capacity. The white race is marked by the thin and straight nose, the black by the broad and flat nose, the Asiatics by a medium shape. None of the lower animals possesses a true chin, while man is never without one, so that the chin is a distinct human sign, as language and the laugh are.

THE PROBLEM OF COLOR

But the most striking difference in races is the color. From this we get the familiar names, the black and white, red and yellow and brown races. These names have always been used and doubtless always will be. Just why it is that these different colors should indelibly mark whole races is one of the things nobody can find out fully. We talk wisely about pigments or coloring matter of the skin which somehow forms and is deposited from capillaries in hairs or on the surface of the dermis or true skin, below the epidermis or scarf skin, and add something about the action of the tropical sun and chemical changes and so on; but the truth is that we do not know exactly why one man is black and another man white, or how each became what he is. The color of the negro is not all a matter of the skin, and that the sun does not account for color altogether is proved by the fact that while the truly black tribes dwell in or near the tropics, all the arctic people are dark, as the Lapps and Eskimos, and the African negroes do not become white after centuries of residence in a temperate zone. The following colors of the skin are easily distinguished:

Dark: (1) Black; (2) dark brown, reddish undertone; (3) dark brown, yellowish undertone.
Medium: (1) Reddish; (2) yellowish, olive.
White: (1) White, brown undertone, grayish; (2) white, yellow undertone; (3) white, rosy undertone.

As to the color of the eyes, light eyes with dark skins are rare, and men's eyes as a rule are lighter than women's. The dark eyes are black or brown, and the light eyes are hazel, gray, and blue.

This matter of color is so interesting that we are going to let our imagination work a little and make a picture of what might have been. You need not believe it, or think it scientific, but our guess is as good as any, after all, — unless you have a better one to offer.

HOW DID MAN BECOME BLACK?

Well, suppose the original color of man was red, as the name Adam (red earth) would imply in the Genesis record. This color was natural to the soil and climate of the original birthplace of humanity or thereabouts. The time came when a group of descendants of this original red man had to go somewhere to find room to grow in, and they moved south-

ward on the African continent, towards the equator, where the climate was intensely hot, fruit was abundant, and all the conditions were favorable to the secretions which come from a sluggish liver and which gradually paint the skin black. The process was slow but sure, and in generations the red was replaced by an ebony black, such as is found among the pure black peoples of the Congo. These African settlers had a small and sluggish brain, as their ancestor was one of the dull boys of the original family. Under the debilitating influence of the hot climate they lived a simple life not far above the animal level, and their children had the same characteristics, remaining savage or, at best, only semi-civilized through the ages. They can be seen to-day in the aborigines of Australia and the Pygmies of Africa, who have not changed materially in thousands of years. Thus the negro race came to have a pretty well-defined character and temperament as well as color. What the effect will be upon members of this race of removal to a temperate zone and close association with the white race is one of the experiments, resulting from African slavery, which is now being watched with great interest in our own country. The negro has shown remarkable progress, but there is no sign of losing the black pigment, even under mixture of bloods. We must remember, however, that it doubtless took thousands of years to create that color. Fifty thousand years from now the human race, united again, may all be of the same color, white or red.

HOW ABOUT THE WHITE MAN?

Suppose now another group of the family, obliged to move or wishing to do so, decided to try its fortunes in the north, and pushed up into the cold forests of the France or Germany or England of to-day. Here, in the forests and under the influence of chilling winds and dark dwelling places in caves and trees and huts, the skin began to bleach out into all shades of white. This group had the brainy boy of the original family for ancestor, and was full of daring and ambition, quick to find a way out of the dangers that threatened from animals and the bitter cold of winter. These people grew hardy, energetic, ingenious, where the African group became fleshy, slow, dull. The northerners became hunters and fishermen, and ate a mixed diet that affected their physique and color. We can imagine how in a period of from five to fifteen thousand years, with such different surroundings and ideas and customs, the descendants who went north and turned white would be so radically changed that they would not recognize as of the same family those once brother red men who went south and became black.

EACH RACE HAS ITS CONTINENT

Just so, doubtless, the original Camel family, which started in North America, would not be recognized as the ancestors of the South American guanaco, vicuna, and llama, or the Arabian camel in Asia. There is in both animal and human life plenty of proof that, whatever be the cause, forces have been at work developing in each great continent animal forms peculiar to itself. When it comes to man, it is very interesting to note that since the dawn of history the different races have occupied each its own special territory or continent. Thus, nearly the whole of Europe and North Africa has been in possession of the white race; Central and South Africa and its islands have been the home of the true negro type; Asia has held the yellow race almost entirely; and the red race has been found only on the American continent.

BLACKS PREFER BLACK, WHITES PREFER WHITE

In accounting for the development of race characteristics, even those as marked as color, one writer calls our attention to the fact that every race, left to itself, finds its highest ideal in its own special racial traits, and seeks to develop these. For example, the negroes of the Soudan see no beauty in the white skin of the Europeans, who seem to the blacks to be "washed out"; while in ancient Mexico, if a child happened to be born of a light color, it was put to death. The white race as naturally exalts the beauty of whiteness, and cannot see any beauty in the dark skin. Whatever the ideal, the possession of it leads to its culti-

vation. We find, therefore, that the negroes preferred a flat nose to a Roman nose, and if a negro child chanced to be born with one of a pointed type it was speedily flattened; just as skulls of children were flattened in tribes where that style was preferred. It is said that in Melanesia, if a child was born of a lighter hue than the village approved, the remedy was found by holding it over the smoke of a fire until the body was sufficiently blackened.

TWO SCHEMES WORTH STUDYING

Sometimes we can see things at a glance in a chart. The two which we give help to show the race conditions at two different periods. The first, which is based on a table by Dr. Brinton, applies to the whole world; the second, by Mr. Elliot, to man in Europe only. A vast space of time is covered by these tables.

When we realize the transformation which civilized man has wrought in North America in four hundred years, and particularly in the last century, we wonder what prehistoric man could have been doing through the long periods, and why he did not get on faster. It also seems as if he must have had a lonely time of it in his long struggle with nature.

BOOKS WORTH KNOWING ABOUT

One of the most interesting books written about the earliest men and their probable manner of life is "The Romance of Savage Life," by G. F. Scott Elliot, published in London by Seeley & Co. It is one of the books to own, fascinating as any novel, full of pictures based on facts. (J. B. Lippincott Co., Philadelphia, are the American publishers.) This volume tells us about the differences between brute, savage, and man; the first home of mankind; the first fishermen, the first hunting savages, the cave men of Europe, the wandering herdsmen, and the first gardeners; about lighting a fire, savage cookery, and the savage infant; about bows, blowpipes, and boomerangs; war, music and dancing, and ornament; about huts and shelters, and the peril of water; about language, marriage customs, death ceremonies, treatment of strangers; about cannibalism, savage beliefs, superstitions, and stories; and about man as a tramp, following him in his early migrations. All this is told in the brightest way, using the imagination, of course, but also giving a host of facts. Some of these we have used in a condensed form, which will make you wish

A Possible Scheme of Things before and after the Year One of History

Geological Period	Conditions	The Human Development
Pleistocene Epoch 1. Pre-glacial[1]	Europe and Africa connected. Climate mild. African elephant in England. Tropical animals abundant.	Man of one type. Simple stone implements. Extensive migrations. Beginnings of language.
2. Glacial	Europe and Africa severed. Low temperature. Arctic animals abundant.	Man dividing into races. Compound stone implements, showing advance in industry. Cave dwellings. Migrations limited. Races in fixed locations.
3. Post-glacial	Continents take present forms; rising temperature; temperate zones established.	Races established. Beginnings of settled life. Languages developing in classes.
Present Epoch 1. Prehistoric 2. Historic	Same conditions of land surface and animal life. Changes through agriculture. Wild animals tamed or slain. Geographic conditions modified by man. Lower animals subjugated.	Races develop in contact. Stone and copper industries. Great migrations begin. Bronze and iron industries develop. The races mingle, and development of nations takes place. Higher civilization begins.

[1] (See p. 68, "The Earth a Storybook.")

to read the whole book. You will do well to put along with this a little book on "Man and his Work," an introduction to human geography, by A. J. and F. D. Herbertson, published in London by Adam and Charles Black. This is a primer full of readable matter.

SCHEME SHOWING HOW ANCIENT MAN GOT ON IN EUROPE

CONDITION OF EUROPE	INHABITANTS
First and most severe Ice Age. — All Scotland, England, Scandinavia, and most of Europe covered by an ice sheet. Snow, ice, violent westerly winds.	*River-drift Man.* — Implements, "bashers" or "knuckledusters" of flint. Remains — two molar teeth.
First and warmest Interglacial Period. — Climate much warmer than it is to-day. Elephants, hippopotami, lions, and other half-tropical creatures prevalent in southern Europe and also in England.	*Men and Women of Grimaldi.*—Long-headed people with negro-like skins and long arms (lately discovered at Mentone, Grotte des Enfants).
Second Ice Age. — Not so severe as the first, but still with a climate in England resembling that of Tierra del Fuego, or the southern island of New Zealand.	*The Cannstadt Race.* — Men with long heads, strong ridges over the eyes, and very low, retreating foreheads. Rude stone implements.
End of Glacial Period. — (*a*) Climate like that of northern Siberia or the Yukon valley in central France, Germany, and England.	*Cromagnon Race.* — (*a*) Strong, athletic, and intelligent, long-headed savages, hunting the mammoth cave-bear, reindeer, horse, etc., in France.
(*b*) Climate like steppes of middle Russia to-day.	*Furfooz Race.* — (*b*) Round-headed savages now appear from direction of Danube valley, and mingle with Cromagnon descendants.
(*c*) Climate approximately that of modern times.	*Mediterranean Race.* — (*c*) Agricultural "Mediterranean race" occupies western Europe and southern England. (A long-headed, short, dark people from Spain and Portugal.)
(*d*) Climate of historic times.	*Aryan Celts, etc.*— (*d*) Appearance of savage herdsmen, using bronze weapons, by way of the Danube valley. Celts (Gaelic and Welsh-speaking Britons). Then later, other Aryans.

THE FIRST MEN OF EUROPE AND THE OLD MAN OF CROMAGNON

Following the story as science reads it, we learn that the belief in a very early man in England rests upon the discovery of two molar teeth and some stone implements or weapons found in the river drift of the Thames near London. The weapons are known as "knuckle-dusters," or flat blades suitable for smashing, like the "woman's knife" of the Eskimo. This "river-drift" man was probably an oyster-gatherer, and carried with him spears of wood hardened in the fire. But two molar teeth are hardly enough to enable one to describe him very accurately, as we shall all agree.

There is more of a story in France, where the race of Grimaldi has been found in recent years and where the Cromagnon race of hunters left traces of themselves for modern anthropologists to study. Mr. Eliot gives an imaginary description of this early man whom he calls the Old Man of Cromagnon. It may be taken as the scientist's picture of the hunter-type of early man.

He was tall (about five feet ten inches in height), sinewy and muscular to an extraordinary degree, with mighty thighs and powerful arms. His forehead was broad and capacious, his brain occupied over ninety-seven cubic inches. He had strong ridges over the eyes, beetling eyebrows, and a prominent aquiline nose. The square-set, projecting jaw was covered by a vigorous beard. His hair will be of that color (red, brown, or black) which it shall please future anthropologists to decide upon. As to his dress it was of the simplest possible character. He wore nothing whatever except a necklace of cave-lions' and cave-bears' teeth. Yet his body was covered all over with iron ochre, or ochre of exactly the tint of the landscape, so that when he remained motionless it was at a short distance off quite impossible to distinguish him. A hunter, he was seriously interested in the game trails, which led to the holes in which lived the fierce bears, hyenas, lions, and other large wild animals. His weapon was a flint spear.

The story of a rhinoceros hunt which follows is thrilling enough for the modern boy, but is too long to give here. A portion of the sketch of the day's events after the Old Man's boy

of fourteen had killed a reindeer is a picture of primitive life too good to omit:

"On arrival at the cave, the older wife was busily engaged scraping with a flint implement the inside layer of the skin of the reindeer. The younger boy was sawing through (with a flint knife) the tendons of its legs, in order to get off the sinews, which were required for twine and bowstrings. A skin had been placed over a small hole dug in the ground, into which water had been poured. Stones were also being heated red hot in the fire. On the Old Man's arrival, these stones were lifted and placed in the water, which was then sufficiently near boiling to cook the reindeer's flesh. Besides this, nuts, berries, and roots were roasting before the fire. After a full meal, the Old Man, contented and happy, stretched himself by the fire. Then, whilst the evening drew in, he amused himself by engraving a picture of the mammoth on a bit of its tusk. The boys were busy chewing strips of reindeer skin to make them supple and pliable enough for lashings to tie on spearheads. After carving the ivory as long as he cared to, the Old Man composed himself for a good night's sleep on his bearskins."

WHERE DID THE OLD MAN OF CROMAGNON'S DESCENDANTS GO?

There is no proof that the Old Man of Cromagnon was a cannibal. What happened to his descendants? It is supposed by many that they migrated north with the reindeer when the climate changed. Those that remained in France seem to have mingled with the first round-headed or Furfooz people, who may have entered Europe by the valley of the Danube. They took to living on fish, small birds, and possibly roots and nuts; in many respects they seem to have deteriorated. But in ancient Gaul, and even in the Paris of to-day, they still exist, as do descendants of his still more savage predecessor, known as the Cannstadt or Neanderthal man. This is not surprising, for Stone Age people have existed everywhere; rude stone weapons like those found in the Thames river drift have been discovered in almost every country in the world.

MAN AS A TRAMP

Man universal is a tramp, a wanderer over the face of the earth. Where did he begin that long and difficult road that has led him from a position of the crudest savagery to that of a twentieth century scholar? We have agreed that the starting point must have been a warm, if not tropical, country. Bamboos were doubtless to be found there, for scraping one bit of bamboo against another is the easiest, and very likely was the first discovered, method of making a fire. In such a semi-tropical jungle we may imagine primal man built his hut in the tree branches, as did also some of the gorillas, sharpened a wooden spear, made bamboo knives, and hunted the animals that were not strong enough or fierce enough to hunt him instead.

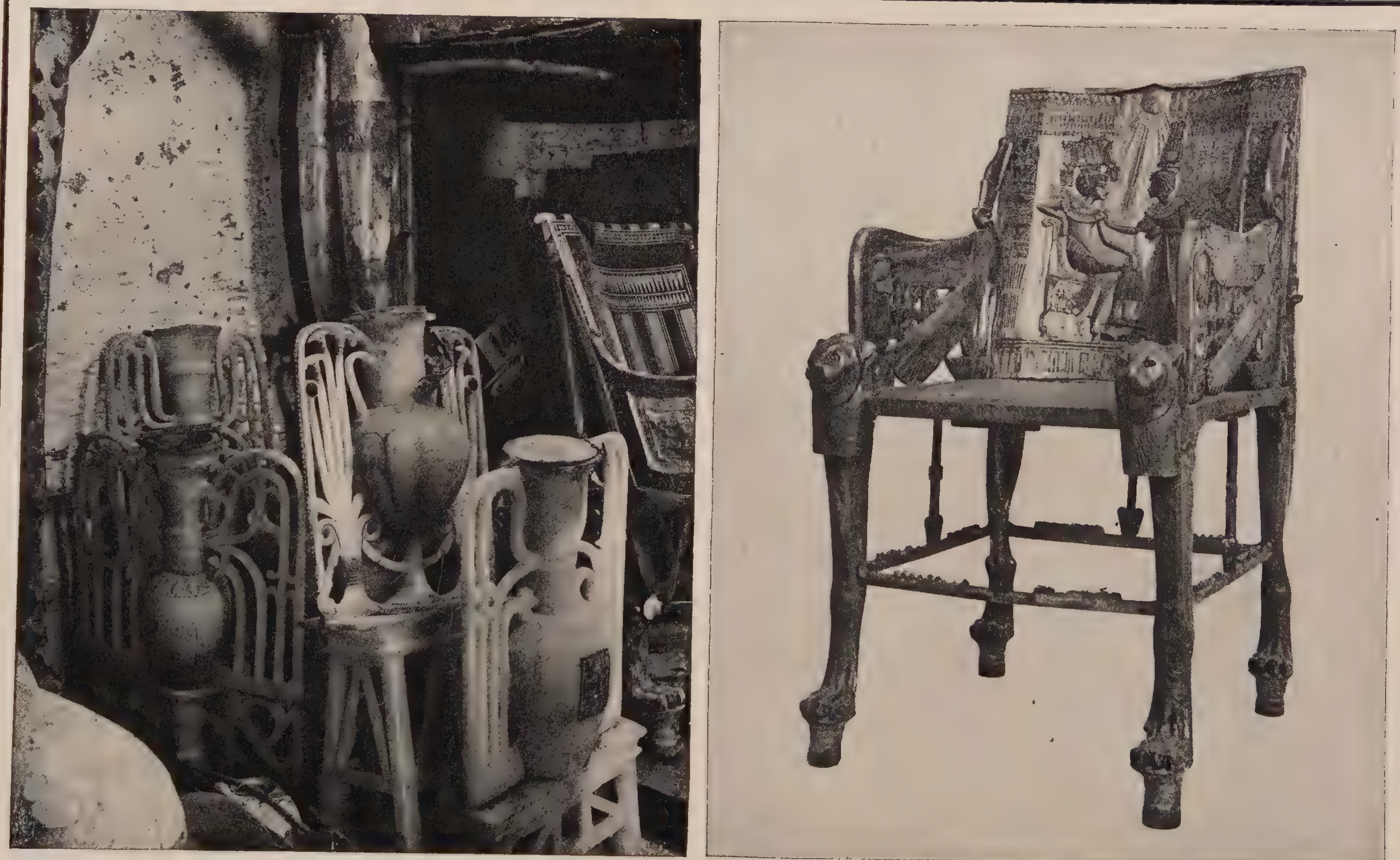
Very soon that jungle, along the banks of streams and the shores of seas, became crowded, and it was necessary to find more room. So man started on his tramp, impelled both by nature and necessity. Up and down the waterways he pursued his wanderings, until he had extended his roamings over most of the habitable land. The motives that prompted this perpetual movement were various: the search for food or for a more congenial climate, the pressure of enemies, the apparently inborn feeling that some other place will be a better place, native restlessness. Such vagrant groups became "the colporteurs and commercial travelers of early society."

WHY MEN HAD TO MOVE ON

Every improvement in weapons of defense and attack, every change that made his life more secure, meant a more rapid growth of numbers, and need of more room in which to expand. At first there must have been plenty of land. Vast forests, rich grass lands, rivers swarming with salmon, wild fruits in abundance, awaited the savage explorer. But this could not last. Even in the Stone Age in Europe it must have been difficult to find a place in which one could fish and hunt without any haunting fear of the flint-head arrows of some prior claimant to the spot. When hunting and fishing were the only ways of getting a living, before

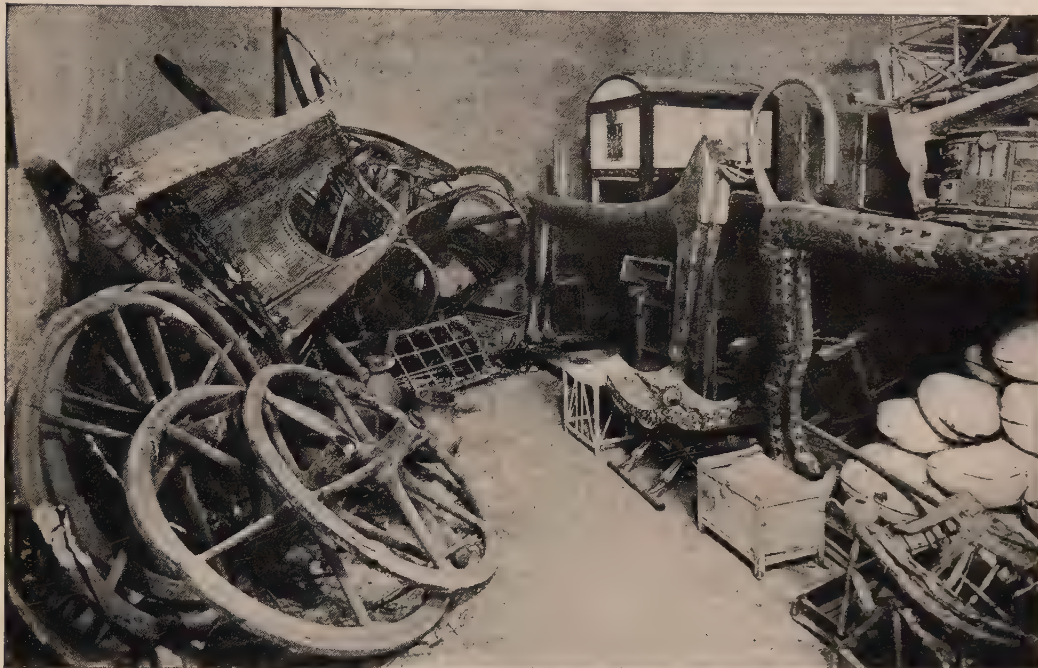
THE TOMB OF TUT-ANKH-AMEN

Lord Carnavon (left) and Howard Carter (right) at the opening of the sealed doorway. [These photographs have been received directly from Howard Carter and are reproduced here by his permission.]



ALABASTER VASES, AND THE KING'S GOLDEN THRONE

In the antechamber stood this beautiful collection of perfume jars in carved alabaster. The throne is a chair of wood overlaid with sheet gold and richly adorned in color.
[Photographs reproduced by permission of Howard Carter.]



AS ONE CORNER OF THE ANTECHAMBER LOOKED WHEN OPENED

[Photograph reproduced by personal permission of Howard Carter.]

A STORY IN PICTURES

THE story told in the pictures on these three pages is of one of the most thrilling finds in the romance of archæology. On November 4, 1922, after six long seasons of unavailing work, the excavation party led by Mr. Carter was on the point of leaving the Valley of the Kings in Egypt and trying their fortune in some other spot when, as he puts it, "hardly had we set hoe to ground in our last despairing effort than we made a discovery that far exceeded our wildest dreams." The first photograph of the Valley introduces the scene of the discovery; its inset shows the leading figures in the episode: Lord Carnavon, who had financed and backed the work for years and shared season after season in its work, and Howard Carter, who made the epoch-making discovery on this November morning of a tomb which proved to be rich beyond all belief in remains of the time, long past, when its king was laid away amid the gorgeous trappings of his earthly life. In the picture of his throne chair we see how gorgeous were the possessions of this boy king of the fourteenth century B. C. in Egypt: the legs of the chair surmounted by lions' heads in chased gold, the arms of crowned and winged serpents, with tintings of violet as well as silver and gold, the back with a beautiful inlaid palace scene of the king and queen. Of the richness of their belongings we get an idea from the beautiful perfume jars set beside one of the couches. Of the labor of preserving and sorting out all these treasures, the photograph above, with its confusion of articles which had not seen the light of day for over three thousand years, gives an idea.

Further investigation led to the room where lay the mummy of the boy king, which Mr. Carter himself reburied in its tomb on October 30, 1926. It is hard to overestimate the value to science of the discovery of this treasure house of the past.

the days of gardening or farming, it required much land to keep a savage family alive. It is estimated, for instance, that the less than one hundred thousand square miles of Great Britain would not have supported more than ten thousand hunting families, which had to be supplied with deer, birds, mice, squirrels, frogs, nuts, crabs, rasps, brambles, etc., for a regular diet.

The wandering groups would at first live from hand to mouth. Then they would probably combine into hunting tribes which followed the deer and wild oxen, and fishing tribes which lived on the water. In time the whole of Europe, from north to south, would be occupied in a scattered way by such wandering tribes, probably resembling the Cromagnon man — such a tall, strong, long-headed, fair-complexioned and fair-haired, blue-eyed race as our Saxon ancestors are thought to have been.

THE ASIATIC HERDSMEN GO WEST

While this was the situation in Europe, other developments were taking place far away in the wide grassy steppes and healthful air of Central Asia, where other groups of the men tramps had gone to find food and dwelling places. As soon as sheep, cattle, and especially horses had been domesticated in the great Asiatic plains, then the herdsmen began their great migrations. It had been found that many families could live together, with herds to support them, and a human society began to exist. But presently there was not grass enough to feed the rapidly increasing herds; the hungry animals had to be driven farther and farther afield, and from the rolling steppes of Central Asia the herdsmen began to wander east, west, and south in search of fresh pasture. Thus began the first Celtic or Aryan migrations, which were to change the face of the earth. Starting in the fertile land near the Crimea, to the north lay the great Russian forest in which animals could not be fed. To the south was the Black Sea. There was only one gateway to new grazing ground, and that was the mouth of the Danube. To follow the river valley was now the only course, for to the south were the mountains, and to the north the dense forest full of wolves, bears, and savage, half-starved hunters. In that fertile valley the herdsmen settled, dividing up into villages, keeping close enough together to unite against any hordes of Lithuanians or Slavs that tried to occupy their ground. It is clear that the people developed by this life would differ very greatly from the hunting and fishing peoples of central and northern Europe.

THE AGRICULTURAL DEVELOPMENT

While this was going on, there was another revolution in human life. At some point in Asia Minor, or the Caucasus, or in Mesopotamia, man, or rather woman, had taken to digging the ground with sticks and to growing corn and vegetables of all sorts. This meant a chance for definite, settled life; it meant villages and, later on, towns, and even great cities. It started the greatest social revolution of the ages. Now large numbers of people could live together, and without much difficulty. A new type of life and character developed, the agricultural type, which became the prey of the strong warrior type. In Egypt, Assyria, Persia, and China the peaceable and easily led soil workers provided the food and wealth which made it possible for the emperors and Pharaohs to conduct their empires and fight their constant wars.

A CHAPTER OF CHANGE FOR EUROPE

When Egypt swarmed with a clever and peculiar race, it was time for another migration. They followed the way to Tripoli and Algeria, settled and built great towns in these countries and in Morocco, then crossed into Spain, went over the Pyrenees and settled in Brittany, and at last invaded England, Wales, and Scotland. They were too many for the red-haired hunting tribes at that time, and occupied all the Mediterranean shore; but northern Europe remained in the hands of the original hunting groups, who were to control the destinies of the world. It is not our purpose here, however, to follow the race in the migrations and wars that belong to recorded history. It is enough to say that when the record began to be written, the dif-

ferent groups had settled in distinctive sections, so that they could be located and marked off. As these groups went north or south, east or west, they found conditions that meant radical change in color, temperament, customs, progress or recession, racial characteristics. On the one hand we find races that have developed a high state of civilization, still advancing as human knowledge grows. On the other, we can point to races which have remained the same for thousands of years, and have not changed their place, their speech, their physical appearance, or their mode of life at all, and their religion and knowledge only superficially. Herodotus, the Greek historian, tells us about a race of Troglodytes who dwelt near the modern Fezzan in Tripoli. They were active and swift-footed, speaking a language known only to themselves. Here we have Nachtigal's Tebus or Tedas, who to this day inhabit the caverns in their rocks. Thus for two thousand years at least, and no one knows how much longer, they have lived in just the same way, no richer, no poorer, no wiser, no more ignorant than they have been these thousands of years. Each generation has repeated the one that preceded. The development of civilization has meant nothing to them.

THE GEOGRAPHICAL DISTRIBUTION OF THE RACES IN EUROPE, ASIA, AND AFRICA

This Ethnographic Map locates the chief divisions of the Human Family on three continents and the islands of the Pacific. The Red Peoples are on the American continents. Note how North Africa belongs to the white race, the more heavily shaded part showing the black territory.

MODERN CAVE DWELLERS IN NORTH AFRICA

In connection with the theory of North Africa as the original home of man, it is a most interesting fact that there are tribes living there to-day in the same kind of earth holes and underground caves that were among the first dwelling places of man. Airmen in some of their flights noticed the strange-looking spot, and photographed the scene from above, before descending to get nearer views of one of the most singular colonies in existence. The name "Troglodytes" was formerly applied to certain ancient cave-dwelling tribes in Mauretania, North Africa, the Arabian coast of the Red Sea, and the coasts of Egypt and Ethiopia, but it is now commonly used for all cave dwellers. The towns of the Troglodytes in the southern Tunisian desert, which has been opened to explorers since the French occupation, are among the chief curiosities of the sea of sand that stretches from the northern coast of Africa to the Soudan. No sign of the subterranean houses, says the artist correspondent of the "Illustrated London News," is visible from the outer world save the holes by which they are entered. Two days' journey south from the Gulf of Gabes, in the Sahara desert, is a chain of mountains called Matmata, inhabited by thousands of Berbers, men as independent as the Swiss mountaineers. In this region it was that a visitor in search of the cave dwellings came to a hole about forty feet in diameter, which was the entrance to a three-story-deep building, in which were living men, women, and children. The walls were perpendicular and were sometimes supported by rough stones. In the walls were irregular holes, some of them closed by rough doors. The vaulted ceiling of the best house of the colony was adorned with stucco and one large room had carpets hanging before the walls, a table in the center, and benches. This was the reception room and council chamber of the Kaid, an old, white-bearded man of patriarchal appearance and ancient family. In Tripoli there are large Troglodyte villages, with thousands of inhabitants, who are all Jews, and have their subterranean synagogues, their rabbis, and their Talmud schools. The cave-dwelling Berbers seem quite content with their lot and with their cave homes, which are warm in winter and cool in summer. These people are believed to be descendants of the Tamahu of the Egyptian monuments; and in their cave dwellings they represent the very earliest of man's abodes. The age of these underground dwellings it is impossible to guess, but they give every evidence of great antiquity, and might easily reach back to the Neolithic period.

ESKIMO BOW MADE OF BONE

TWO CLASSES — THE BOW-AND-ARROW AND THE BOWLESS

The human race inhabits countries and islands in the temperate and torrid and frigid regions of the earth. Some races are isolated, others are in an intermediate position. The northern hemisphere contains a larger number of persons than the southern; it offers wider districts to open up, with more sides of contact and richer possibilities. In position, form, and dimensions it has from early time had the advantage as regards the development of humanity. The distribution of man is based on interdependence in the northern, on separation in the southern hemisphere. The Negroids belong to the south, the Mongoloids and whites to the north. Civilization has reached its highest developments north of the equator. The bowless races belong to the southern groups, whereas in the north we find bows and arrows, not only over a broad zone, but on fundamentally the same models, from Lapland to East Greenland and Mexico. The bow-and-arrow man is the aggressive hunter, the man of resource and action, the get-ahead type.

HOW CIVILIZATION PROMOTES POPULATION

The numbers of mankind are closely dependent on their territory. The total figure, as now estimated, of one billion five hundred millions must be regarded as the result of a development never before attained. Hunting races are thinly scattered. Agriculture tends to increase the density of population; fishing

A TOWN OF DWELLERS UNDERGROUND PHOTOGRAPHED BY MEN OF THE AIR: TROGLODYTES' HOUSES

As seen from the Italian dirigible balloon "P2"; a photograph taken in Tripoli, North Africa. No sign of these cave dwellings is visible from the outer world save the holes by which they are entered. Some of the underground houses are three stories deep, and are very well built.

INDIAN PICTURE WRITING, THE ORIGINAL METHOD

and agriculture combined increase it still more; trade and industry greatly multiply the density per square mile. All races in a state of nature live thinly scattered. Civilized populations are marked by greater density. In density of population lies not only steadiness and security for vigorous growth, but also the immediate means of promoting civilization. The closer men are to each other, the more they can impart. Six-sevenths of the earth's inhabitants belong to civilized countries.

UNIQUE HUMAN CHARACTERISTICS

MAN'S REMARKABLE THUMB

DO you know that the thumb is one of the most remarkable things a man possesses, and that it marks him as distinct from all other animals? That is the fact. What is called the "opposable" thumb — that is, a thumb that can be brought into play against all the other fingers of the hand — is a sign of man. It is this thumb that makes it possible to grasp objects, and to do the most delicate work as well as that requiring great strength and skill. Man without a thumb could never have made tools or handled them, could not have built a home or defended himself. When you think of it, and try to do things without using your thumbs, you will see what this part of the human hand means. One of the distinctions between man and brutes is that all living races of mankind possess weapons or tools of some kind. It took man with a thumb to make the weapons and tools. Here, then, are some of the human distinctions:

Man, only, of the mammals, walks erect.

Man, only, is endowed with language.

Man, only, can read and write, and count numbers.

Man, only, has a sense of morality and duty, and religious instincts.

Man, only, has a well-developed opposable (prehensile or grasping) thumb.

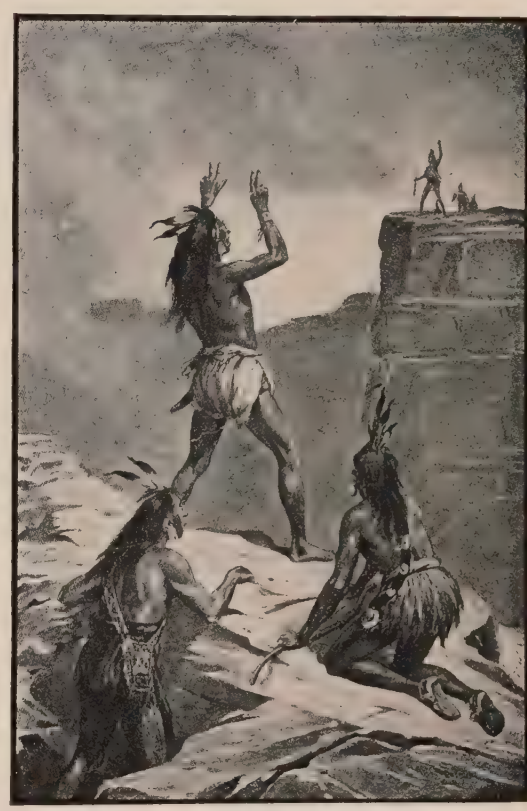
LANGUAGE

Language is the peculiar property of the human species, and in itself marks man as

unique. All efforts to prove that the highest apes have a language have been in vain, whereas no tribe has been known, not even the lowest in the scale of intelligence, that has not had an articulate speech with plenty of expressions for its ideas. Dr. Brinton says that the stories of savages so rude that they were forced to eke out their words with gestures, and could not make themselves understood in the dark, are fables. The languages of the most barbarous communities are ample in forms and often surprisingly rich and sonorous. Of course language must have had a beginning, and we may imagine that the primal man had no parts of speech, such as nouns, prepositions, or adjectives, no numerals or conjugations; but the different sounds, vowels or consonants, would mean specific things, and each idea would be conveyed by a single picture word or sound, as in the Chinese. Spoken language came long before written, pictographs doubtless forming the first attempts at the latter. The Indian picture writing is exceedingly interesting. Rude drawings show how early the artistic instinct developed. Developed thought resulted in writing by alphabet instead of pictures. The highest advances of civilization have been marked by a brilliant literature and the constant enrichment of language, until in the English language we have at present the noblest and moxt flexible medium of human expression, apparently destined to become the universal language.

MODESTY AND DRESS

The sentiment of modesty is developed by man in society, and he alone among animals possesses it. It is never absent in any race, although its manifestation differs. Women with us expose their faces, which a Moorish lady would think most indelicate. In the most savage tribes a regard for decency is constantly noted. Clothing, while in many cases closely allied to modesty, is more frequently a matter of pride, as a part of bodily adornment. Some think that clothes were first worn, not so much for protection from cold as for ornamental purposes, the men loving gay colors quite as much as the women, and devoting as much time to dressing the hair and painting the body. Among the Fijians, for example, every chief has a hairdresser who operates upon him every day, sometimes for hours. Tattooing is religious in its origin, and called for Spartan endurance, but it was among many tribes a matter of pride also; and sailors of civilized races show a similar pride in having undergone the pain of the tattoo. The encouraging fact is that genuine modesty, which is an element of true refinement, is inherent in the races of all grades.



INDIAN SIGN AND GESTURE LANGUAGE

Question: Who are you? Answer: Pani.

ART, SCIENCE, AND EDUCATION

Man is the only creature capable of self-expression through creative work in art, science, and invention. He alone is capable of education and culture. He stands so far removed from the highest of other animals in his social, ethical, moral, and religious, as well as intel-

WAR FLEET OF TAHITI WITH THE PRIEST IN THE PROMINENT POSITION

lectual qualities, that it is no wonder thoughtful men say that it would be less of a miracle to create such a supreme being by special act than to evolve him out of any lower form of animal.

RELIGION

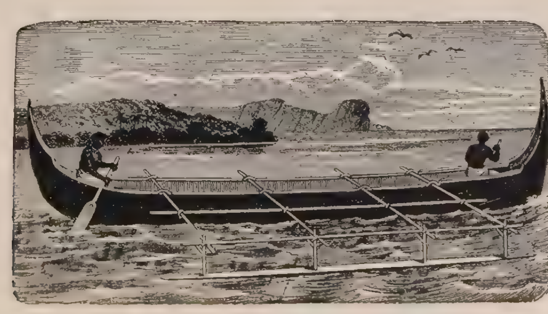
Man alone of all creatures is capable of religion. Not only is he capable of it, but it is positively declared by the closest students that he has never been known to be devoid of it, if by religion we mean the recognition of the Unknown or a higher power as a controlling element in the destiny of man and the world about him. This is found in the heart of every man, even the most degraded and savage. By nature man is a religious being. Superstition, in the form of animism or dread of demons, is the prevailing force in the life of most savage or semi-civilized peoples; but underneath is a religious consciousness that responds to the appeal of conscience. While perhaps only the few have risen to the conception of the spiritual in religion, the masses of mankind have known veneration and the spirit of worship, and it is doubtful whether any tribe has been utterly without the idea of God. While efforts to propitiate evil spirits have filled the records of many peoples with fantastic and pitiful chapters, even in this the religious impulse is apparent. First came the tribal religions, which prevailed in early historic times. These were followed by the world religions — Christianity, Mohammedanism, and Buddhism — all of which came through members of the white race, and the first of which lies at the foundation of the nations which have achieved the greatest results in all that makes for the highest welfare of mankind.

THE WHITE RACE

If the white race finds little place in the sketches of peoples which follow, it is because the works of that race fill all our volumes, as its records fill the pages of history with events familiar and famous. The white race has always been the conquering and creative race. It is sometimes called the Caucasian, sometimes

the European. A new name has been suggested, the Eurafrican, combining European and African, and pointing to the fact that Africa is not simply the continent of the black peoples, as it has usually been regarded, but the place where very likely the white race made its first appearance, where it had the seat of its earliest culture, and at first its greatest possessions of territory. The most recent discoveries in the pile dwellings of the Swiss lakes and the plain of the Po show that the same race inhabited them from the classic age of Greece to far back in the Stone Age. The purest types of the whites in any large number have always been found in western Europe and northwestern Africa. The shores of the Mediterranean gave them a home before the migrations to Asia. In the Bronze Age there appeared in this race, in northern Europe, the peoples that we know as the Teutonic, who make up the strongest nations of to-day. They possessed the sturdy qualities and the ambition which are necessary for the conquest of nature and of all obstacles to progress. This is unquestionably the most influential and progressive group of peoples on the globe, largely controlling the politics and destinies of the world. It is a significant fact that while the yellow race was in seclusion, and the black and red races were in savagery, through the long centuries, the white race was developing the splendid civilizations of history — the Egyptian, Assyrian, Babylonian, Jewish, Greek, and Roman — and the modern nations which are the world powers. To this race the world owes its art, science, and literature, with such exceptions as only make its creative genius more conspicuous by contrast. It is this stock, with its intermingling of white bloods, that has initiated the great forward movements of humanity, filled the lands with inventions and the air with flying ships, established democracy and free government, and held to the highest ideals of morality, liberty, fraternity, and equality.

The white race goes forth conquering and to conquer, extending its empire over all continents and to the remotest islands of the sea. Never has its progress been so rapid as now. Two centuries ago the whole of the white race which could lay claim to purity of blood numbered not over one hundred millions, or ten per cent of the population of the world, and was confined to the limits of Europe and North Africa; now the European branch of it alone counts nearly five hundred millions, or one third of the whole. No nation and no race of other lineage dare withstand an attack or disobey an order from a leading European power. But it is not in military strength that the glory of these world powers lies. It is rather in their aims and the character and achievements of their peoples. If the white race is to win, it will be because its ideals are those of universal brotherhood and its cause that of righteousness and good will to all men. Having seen what the early conditions were, and something of the steady advance through the ages, we may well believe that the whole human race will yet become as one great people, united in order to accomplish to the full its high destiny — the establishment of the reign of righteousness and peace on the earth.



OUTRIGGED BOAT, NEW BRITAIN

TYPES OF THE RACES, FROM PHOTOGRAPHS

Top Row: Workii Tribe Man; Woman of Tonga Islands; King of Tonga Islands; Fiji Woman; Tattooed Maori Chief.
Center: A Man of Fiji, with necklace of cachalot teeth: a fine type.
Left Side: Maori Girl; Negrito Man; Burmese Lily. Right Side: Admiralty Island Woman; Tasmanian; Moro Indian Girl
Bottom Row: Kanowit Chief; Three Samoan Belles; Talolo, R. L. Stevenson's favorite Cook.

THE RACES AS THEY ARE TO-DAY

CAUCASIC OR WHITE DIVISION

Present Domain: North Africa, most of Europe, parts of Southwest and Central Asia, South Africa, parts of Siberia, Irania, India, Indo-China, and Malaysia, Polynesia, Australia, New Zealand, North and South America.

Population: Europe, 355,000,000; Asia, 300,000,000 (estimated); America, 115,000,000; Africa, 20,000,000; Australasia, 10,000,000. Total, 800,000,000 (?).

Physical Characters: Three types (1) Northern or Teutonic; color white or florid; height above average (5 ft. 8 in. to 6 ft.). (2) Central or Alpine; color pale white; height medium (5 ft. 5 in.). (3) Southern or Mediterranean; color pale olive or swarthy; height generally undersized (5 ft. 4 in. to 5 ft. 6 in.).

Religion: Originally nature worship; now various forms of Christianity in Europe and the Colonies; Hinduism in India; Islam in Central Asia, Siberia, Turkey, Arabia, North Africa, Irania, India, Malaysia.

Chief Subdivisions: Hamites, Semites, Aryans (including most Europeans), Polynesians.

MONGOLIC OR YELLOW DIVISION

Present Domain: Tibet, Central Asia, Mongolia, Siberia, Manchuria, Korea, Japan, Formosa, China, Indo-China; parts of Irania, Armenia, and Caucasia; most of Asia Minor; parts of Russia, Finland, Lapland, the Balkan Peninsula, and Hungary; most of Malaysia, the Philippines, and Madagascar.

Population: China, 400,000,000; Japan and Korea, 58,000,000; Mongolia, Manchuria and Siberia, 25,000,000; Central and West Asia and East Europe, 20,000,000; Malaysia and the Philippines, 48,000,000; Tibet and Indo-China, 45,000,000. Total, 596,000,000.

Physical Characters: Color yellowish and light brown; height rather under average (5 ft. 6 in.), but tall (5 ft. 8 in. or 5 ft. 10 in.) in North China and Manchuria.

Religion: Animism, worship of ancestors, nature spirits. Religions largely a question of race, Manchus, Koreans, Japanese, Chinese, Indo-China, and Tibetans being nominal Buddhists; the Turks, Tartars, and most Malays, Mohammedans; the Finns, Lapps, and Magyars now Christians. Also Confucianism and Taoism in China, Shintoism and Bushidoism in Japan.

Chief Subdivisions: Manchus, Koreans, Japanese, Turks, Finns, Lapps, Magyars, Tibetans, Burmese, Siamese, Chinese, Japanese, Dyaks, etc.

AMERIND OR RED DIVISION

Present Domain: Arctic seaboard, Greenland, Alaska, Canada, and the United States; most of Mexico, Central and South America.

Population: Full-blood Amerinds, about 10,000,000; Mestizos or half-breeds, 30,000,000 (?). Total, 40,000,000 (?).

Physical Characters: Color normally reddish or coppery, but variable, some very dark brown, some yellowish (Amazonians). Height generally well above average (5 ft. 8 in. to 6 ft. and even 6 ft. 4 in.) (Bororos, Patagonians); but some very undersized (5 ft. to 5 ft. 4 in.); as a rule prairie Indians tall, highlanders short.

Religion: Shamanism — worship of good and evil spirits; animal worship; sun worship.

Chief Subdivisions: (1) Northern: Eskimo and American Indian tribes — Apache, Navajo, Cree, Mohican, Delaware, Shawnee, Cheyenne, Huron, Mohawk, Cherokee, Seminole, Choctaw, Creek, Pawnee, Pueblo, etc. (2) Central: Aztec, Zapotec, Chiriqui, etc. (3) Southern: Incas, Carib, etc.

NEGRO OR BLACK DIVISION

1. *Eastern* (*Oceanic*) *Section*

Present Domain: Malay Peninsula, Andamans, parts of Eastern Archipelago and Philippines, New Guinea, Melanesia, Australia.

Population: 2,000,000 (?), chiefly in New Guinea and Melanesia.

Physical Characters: Color very dark brown or blackish; height generally below average of 5 ft. 6 in.

Religion: Spirit worship, with tabu in Melanesia and totemism in Australia.

2. *Western* (*African*) *Section*

Present Domain: Madagascar, North Africa, Southern United States, West Indies, Latin America.

Population (pure and mixed): Africa, 180,000,000; Madagascar, 3,000,000; America, 25,000,000. Total, 208,000,000.

Physical Characters: Color very dark brown or blackish; height above average (5 ft. 8 in. to 6 ft.); but Negritoes generally 4 ft. or under.

Religion: Animistic, ancestor worship much more prevalent than nature worship.

Chief Subdivisions: Soudanese (Negroes proper) between the Atlantic and Abyssinia and in the Welle Basin; Bantus (mixed negroid peoples) occupying nearly the whole of Africa south of the Soudan; Bushmen and Hottentots, Southwest Africa; Negritoes, Congo and Ogoway forests; Vaalpens, Transvaal.

THE QUEER PEOPLE OF THE WORLD

THE BLACK, BROWN, RED, AND YELLOW RACES AND THEIR WAYS

WHAT makes a people queer? Perhaps the best answer is found in the story of the old Quaker who said to his wife one day, "Everybody in the world is queer but thee and me, and sometimes I think thou art a bit queer!" To be queer is to be different from what is ordinary and normal. Each one of us decides from his own experience and surroundings what is natural and reasonable. Then we feel that everybody who departs from these ways of ours is a bit queer.

So "queer peoples" are no more strange and odd to us than we are to them. If you visited some of the places and tribes about which you are going to read, you would find yourself such an odd sight that children and grown persons would turn and follow you in the streets, just as you might turn and follow a circus parade if you met one. In the great human family there are many peoples whose ways and habits are unlike ours, and our interest is in these very differences. Some are uncivilized, and so take us back to a kind of life more like that of our ancestors than anything we are acquainted with; others are highly civilized, but their civilization is on another plane from ours. Because people are the most interesting part of God's universe, we like to read about these other members of the human family who are our brothers and sisters even though they wear different clothes, eat unfamiliar foods, and live in unaccustomed ways. It is impossible to tell about all the interesting peoples, but a few of them will show you how fascinating the story of other nations is. All your life, as you travel and read and meet men and women, you will be adding to your knowledge of the many members of the great human family.

PEOPLES OF THE NEGRO OR BLACK DIVISION

First, let us take some of the black peoples, who live mostly in the Soudan, South Africa, and Australasia, but have migrated to many other parts of the world. Some of the most interesting of these black-skinned peoples live still in Africa. The true black people are the Negroes, whose home is in the middle part of Africa. They are the people with the black skins, the woolly heads, the thick lips, the flat noses, and the beautiful white teeth. The home of the Bantu race is the great southern section of Africa. They are not so black as the Negroes. Both peoples are brave, intelligent, and able to adapt themselves to new conditions and take on civilization. Smaller tribes are the Pygmies, the Hottentots, and the Bushmen, all far below the Negroes and Bantus in intelligence.

AFRICAN PEOPLES

1–2, Mpongwe (Gabun); 3, Arabs (Morocco); 4, Arabs (Tunis); 5, Fellah; 6–7, Copts; 8, Nigerian; 9, Fan; 10, Berber; 11, Negro; 12, Nubian; 13, Congoese; 14, Zulu; 15, Bagirmi boy; 16–18, Africans; 19–20, Abyssinian; 21–22, Hottentots; 23, Betschuan maiden; 24, Akka; 25–26, Bushmen; 27, Madagascan; 28, Zanzibar negro; 29–30, Somali.

THE WILD BUSHMEN

HUNTERS

THE Bushmen are the true aboriginal people of South Africa, the earliest known inhabitants, as the Indians are the aboriginals of our own country. When we come to them, we have gone back many stages in the world's development, back to the days of the childhood of man, for here we have a race that has always been a hunting race. Almost every people has passed through a hunting stage in its development. The Bushmen stayed at that stage. They represent the typical hunters of the world. Free of all property, never settled in one place, never held by any industries or agricultural ties, they range the hunting grounds of Africa. Their arrows are tipped with wood, bone, or stone. They need no home, for they can make one in a few hours out of brushwood. Their usual garb is a robe of sheepskin thrown over the body and fastened with a sharp thong. The Bushman needs no fireplace or cooking utensils, for his only way of preparing food is to throw the raw flesh on the fire or on hot stones for roasting.

HOW THEY LOOK

The most conspicuous feature of the race is their shortness of stature, the average height being about four feet nine inches. The color of the skin is much lighter than the Negroes, and the hair, instead of being evenly distributed over the top and back of the head, grows in small separate tufts, like little islands with stretches of bare scalp between. Their eyes are very small and deeply sunken in the head. Their sight is wonderful. They can see without a telescope about as well as the ordinary person can see with one.

HOW THEY HUNT

For food the Bushmen eat every creeping, running, and flying thing they can lay their hands on, including snakes and slugs. They are bold and skillful hunters of the ostrich, the lion, and the leopard, and their only weapon is a poisoned arrow. In hunting the ostrich they show great ingenuity. They have no horses, and to pursue this bird on foot would be hopeless. Accordingly the Bushmen have two modes of getting within range, which in the flat, treeless country frequented by the ostrich is no easy matter. In the first place the little hunter finds the large ostrich nest while the parent birds are away. He knows that several ostriches will deposit their eggs in one nest, so that a number of them will come back together. He approaches very cautiously and buries himself in the sand among the eggs. Here he will lie patiently until the sun has gone down, when he knows the parent birds will return to the nest. As soon as they come within range he picks out the bird that has the plumpest form, and with a single arrow seals its fate.

The chief drawback to this mode of hunting is that the very act of shooting the arrow reveals the hunter and frightens the other birds away, so that there is no chance for a second shot. So he tries another method. When he catches a glimpse of a number of ostriches together, he dresses himself up in the skin of an ostrich, so as to make the birds think that it is only another of their number feeding near them. Approaching in this manner, he is sometimes able to secure several of them before they get out of his range.

HOW THEY DEFEND THEMSELVES

The Bushman obtains the poison for his arrows from a native caterpillar. And had he not this protection, he would soon be exterminated by his cruel enemies, who are only kept at arm's length by the knowledge of the deadly effect of this little weapon.

A single Bushman lurking in the neighborhood will keep a whole settlement in terror. Sentries are almost useless when he chooses to make his night attack, for he can crawl unseen within a few yards of the sentinel, lodge a poisoned arrow in his body, and vanish as silently as he came. As to finding the retreat in which he hides himself by day, it is almost impossible, even for a Hottentot, for the Bushman is marvelously skillful in covering up tracks, and has besides the art of packing his tiny body into so small a compass that he can lie at his ease in a

BUSHMEN AND THEIR DRAWINGS

1. Four typical Bushmen. 2. The Bushmen have stolen some cattle from the Kaffirs and are driving them off, the Kaffirs in pursuit. 3, 8, 9. Animal figures, drawn on walls of caves. 4, 7. Hunting scenes. 5, 6, 10, 11. Charms, and a festival dance.

hole which seems hardly large enough to accommodate a large rabbit.

BUSHMEN AS STORY TELLERS AND ARTISTS

In the stories of the Bushmen we get beast fables and nature myths in their original form. As a group of men, women, and children sit about a fire, one will begin to tell a quaint old story. When the different animals who are the characters in the tale make conversation with each other, the story teller will imitate the sounds which each has made until the language sounds to one who is listening like a mixture of half-animal, half-human talk. These stories tell how the sun and the moon happened to be tossed up to heaven. The moon is red and cold because it was an old shoe that the monkey threw there to get it out of the way. The shoe was dusty, so the moon cannot shine as brightly as the sun; the leather was cold and dead, so the moon is.

THE BUSHMEN AS ARTISTS

But it is in Bushmen drawings that we get the best ability of these primitive peoples. They show not only clever ideas, but real skill in working them out. Every picture has a story which it is easy to trace. They are drawn in the caves or rock shelters which are the only permanent homes of the tribes. The subjects are mainly men and animals, and are drawn so accurately that the different kinds of animals, the elephant, rhinoceros, baboon, lion, giraffe, and antelope, can be easily distinguished. There are drawings of the square-nosed rhinoceros, which has not been known in Africa in historic times; and there are pictures of red-coated soldiers which must have been done by artists of the last hundred years. The figures are colored black, red, brown, or terra-cotta. It has been suggested that these are also parts of a picture language such as that used by the North American Indians.

From their stories and pictures and customs we find that the Bushmen have a shadowy belief in spirits and in a life after death. At the grave they talk to the spirit that has gone, and they have a beautiful proverb, "Death is only a slumber."

THE HOTTENTOTS

FROM earliest times the Hottentots have lived in South Africa. They are found scattered in groups up into the very heart of the continent, and in some places along the western coast. They are not dark like the other African natives, but yellowish, more like the Chinese. Having long mingled with the Europeans, many of them now wear European clothing. They do not like regular employment, and when they enlist in the army it is generally with the understanding that they shall fight only when it seems good to them, and run away when they feel like it.

The Hottentots rove about, living a few days in one place or a few years in another. Their common huts are round, cage-like frames, covered with mats or skins, and can be taken down or put up very rapidly. They are warm and fairly water-tight, but these very qualities which keep out the wind and water also keep in the smoke of their fires, so that nobody

LIFE AMONG THE KAFFIRS

1. A Kaffir Hut. 2. Young Kaffir. 3. Kaffir Dinner Party. 4. Kaffir Kraal. 5. Utensils. 6. Soldiers Lapping Water. 7. Exterior Kaffir Hut. 8. Apingi ejecting a Demon. 9. Necklace of Human Finger Bones. 10. Unfavorable Prophecy. 11. Prophet's Return. 12. Fowl House. 13. Prophetess at Work.

but a Hottentot can stay long in a Hottentot hut.

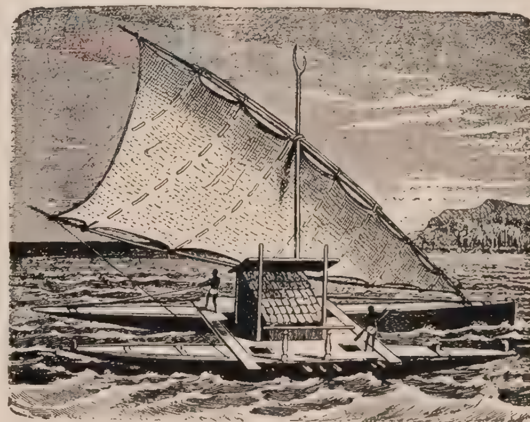
When these people can get food they are enormous eaters. When an elephant or any other large animal is killed, the people of the kraal, or village, as soon as the news comes, strike their tents, and remove to the neighborhood of the animal, finding it easier to take their houses to the game than to bring the game home. The meat is roughly boiled, and the men, women, and children eat until full. Then they throw themselves back and sleep a few hours, only to wake up and again attack the food until the bones are picked clean. A Hottentot can sleep at any time. If he has plenty to eat he is forced to sleep. If he is hungry he sleeps as a relief.

AMUSEMENTS

Their common amusements consist chiefly in singing and dancing, and playing a curious instrument called the Goura. In dancing they join hands and form a circle. They turn round from one side to another, separating at certain intervals to mark the measure, and then from time to time clap their hands and chant, "Hoo! hoo!" Sometimes one of the dancers goes into the center and performs there alone a few steps after the English manner. Then they all drop hands, follow one another carelessly, with their heads leaning on one shoulder and their eyes cast down on the ground. A moment later they break forth in great joy and merriment, and the dance is ended.

There is a curious dance, much liked by the Hottentot girls, called the Melon Dance. In the evening, when the air is cool, the girls gather and choose one of their number as a leader. She takes a small round melon in her hands, and begins to run in a circle, waving her arms. The others follow her and imitate her movements. While running she flings the melon in the air, catches it, flings it again, and at last stoops suddenly, leaps into the air, and throws the melon beneath her towards the girl who is behind her. This girl has to catch the melon without stopping from her course, and the first has to throw it when she thinks that the second is off guard. So she pretends to throw it several times before she actually does. If the second girl fails in catching the melon the first continues as leader, but if she succeeds she becomes leader. In this way the melon goes round and round, and the sport is continued until the dancers are tired out.

The Hottentots have no idea of the division of the day into hours. If a man asks a Hottentot how far it is to such a place, he either makes no answer or points to a certain spot in the heavens and says, "The sun will be there when you get to it." Their folklore, like that of the Bushmen, is rich in animal stories of the "Uncle Remus" type.



FIJIAN DOUBLE CANOE

A plan adopted by some modern boat builders.

PYGMIES

WHEN you see a dwarf in a company of men and women, you notice that everyone turns to look at him. It is not a common sight with us. Yet in South and Central Africa, and in some of the Pacific islands, there are whole villages of these little men and women, or Pygmies, as they are called, none of them much more than four feet tall.

In many ways they are like the Bushmen and Hottentots, but the color of their skin is paler, almost yellow, and their hair is short and woolly and black. They do not tattoo themselves, as do their taller neighbors, and they wear but few ornaments. The men wear arm-bands and leg-bands of braided fiber, and sometimes necklaces of seeds, scraps of broken shell, or teeth of kangaroos. How would you like to wear a string of kangaroo teeth around your neck?

They pay very little attention to the matter of clothes, but always carry a bag slung across the shoulders, usually hanging down the back, and sometimes a second one hung over the chest. In these bags the Pygmy keeps all his goods — his sleeping mat, his bone and shell ornaments, his knives, his firestick and rattan, and his bow and arrows.

THE WAY THEY LIVE

A common method among them of making a fire is to pass a rattan line round a piece of dried branch, holding the branch down with the feet, while the line is rapidly worked back and forth with the hands. Flint and steel are also used.

The Pygmies never cultivate the soil, but support themselves chiefly by hunting and trapping and by the preparation of palm oil. They use small bows and tiny arrows, which they can shoot with great skill. The woods in which they live are so filled with their traps that a stranger dares not walk in them, lest he tumble into a pitfall prepared for the leopard, wild boar, antelope, or monkey.

As a rule their homes are better than those of the taller people around them. The houses are built on piles, which raise the floor of the house from four to ten feet above the ground, according to the steepness of the slope underneath. The walls are made of laths of split wood, with big sheets of bark fastened on the outside. The roof has a steep pitch, and is covered with palm leaves. The floor is made like the walls, having a carpet of bark. In the middle of the floor is a square sunken box filled with sand or earth, in which a fire is kept burning; and from the roof above the fire hangs a rack on which wood is placed to dry. The houses are entered by a steep ladder made of two posts tied closely together, which leads to a narrow platform, or balcony, in front of the house. There are no notches on the posts, but the lashes of rattan which tie them together answer the purpose of steps or rungs for the feet.

The Pygmies are very timid, and it is hard for travelers even to catch sight of them, especially of the women, for they will dash into the woods and hide the moment they see a stranger approaching. Their knowledge of the woods makes them good spies or scouts, and some of the richer, more prosperous tribes employ them to guard the frontiers. They are regarded as kindly little people whose special mission is to provide the surrounding tribes with game and palm oil. In spite of their timidity, they have a keen sense of humor, comic ways, and amazing talent for mimicry.

SOLOMON ISLAND WARRIOR

THE FUZZY-HAIRED PAPUANS

THE Papuans are a branch of the Oceanic Negroes. They live on islands in the southern Pacific Ocean, chiefly on Fiji, New Guinea, and the chain of islands lying east of Australia and extending northwest to the Philippines. Perhaps the Nicobar and Andaman islands ought to be looked upon as belonging to the same people. The name "Papua" comes from a Malay word meaning "woolly" or "fuzzy," and was given to this queer race on account of their great mop of hair.

APPEARANCE

The color of the Fijians is a chocolate-brown. There are, however, two shades very clearly marked, like the blonde and brunette complexions of the white race. A Fijian's hair is stiff and wiry, and he trains it to stand out at right angles from the skin. About one third of the hair around the front of his head is of an ashy or sandy color and the rest is colored black.

It must be rather troublesome to keep this heavy mop of hair in order, and as a matter of fact the men of Fiji spend a great deal of time in dressing it. Nearly every chief has a hairdresser who operates upon him every day, sometimes for several hours. A chief sometimes protects his hair by a kind of turban, made of very delicate bark cloth, as thin as gauze. The Fijians are all fond of wearing flowers. They use them as hair ornaments and weave them into belts.

POLITENESS AMONG THE FIJIANS

They are fond of feasting and giving entertainments on a large scale, and on these occasions their manners are extremely polite. Everything is done according to a strict code of etiquette; indeed, they are among the most ceremonious people in the world.

When two people of equal rank meet early in the day, the correct phrase is, "Awake!" or "You are awake!" In the evening they will say, "Sleep!" or "Go to sleep!" In offering a gift they say, "I have nothing to offer you but this gift as an expression of my love for your children."

CANNIBALISM

You have all heard of cannibals, that is, savages who eat human beings. You will be surprised to hear that these Papuans, who can be so polite to one another, were, until within recent years, given to this dreadful habit of cannibalism. The idea of eating others was that when a man ate another man he acquired the victim's qualities, physical strength, courage, cleverness, or cunning. Since the coming of the missionaries to the islands the Fijians have largely become Christians, and have given up cannibalism and almost all their other barbaric customs.

ONE WAY TO REMEMBER

In their savage state these people have no idea of writing. Accordingly, when delivering a message, they use a bundle of sticks, no two being of the same length. Each stick answers to one of the terms of the message, which is repeated once or twice to the ambassador, who reckons them over on *his* sticks. When he in turn delivers his message to his chief, he unties the bundle, selects the sticks in order, and laying them down one at a time, delivers the message without a mistake.

FISHING AND FIGHTING

The Papuans are expert fishermen. Nets, weighted at one edge with shells and floated at the other with pieces of light wood, are much used; and so are the hook, the creel, and the weir. The principal use of the net, however, is in turtle fishing. The best example of the Fiji canoe is the double one, where two boats are placed side by side in such manner that one of them acts as the outrigger and the other as the canoe. The two canoes are covered over to keep out the water, and are connected by a platform which projects over the outer edges of both boats.

Their weapons are the club, the ax, the bow, the sling, and the spear. When two chiefs have decided to go to war, messengers pass between them, and both sides beat up recruits for their armies and offer gifts to the gods. Whales' teeth and food are the chief offerings. They have a curious custom of giving a new name to men who have killed any of the enemy during the campaign. Should one kill a chief, he takes the name of his victim.

PAPUANS AT PLAY

The Papuans have many amusements. Some of them are the same as our children's games, such as cat's cradle, hide-and-seek, blindman's buff, and a sort of hop, skip, and jump. Pitch and toss is also played, the round fruit of a species of mimosa being used instead of coins.

PAPUANS IN SINGULAR MOURNING COSTUMES

Above: a woman wearing a widow's costume of grass, and a man caked with mud and wearing a necklace to show his grief. Below: belles in full dress, and a beau with a glued-on hat.

Then there is the swing. The rope has a loop at the end, into which the swinger places his foot. Sometimes it is a large knot, on which both feet can be supported. Drawing the rope to the top of a convenient bank, the swinger grasps it with his hands, leaps into the air, places his foot on the loop, and goes sweeping through space often at a distance of fifty feet. An amusing game is often played by the young men. A thin earthenware vessel is filled with water and hung from a bough of a tree, and a number of young men with their eyes blindfolded try to break the vessel by striking it with long sticks.

There is one missile used by the native Australians that is popularly called the "kangaroo-rat," on account of its leaping power. It is a piece of hard wood shaped like a double cone, having a long, flexible handle about a yard in length. At a little distance it looks like a huge tadpole with a long tail. In throwing the kangaroo-rat the native takes it by the end of the tail and swings it backward and forward so that it bends quite double, and at last he gives a sort of underhand jerk and lets it fly. It darts through the air with a sharp hiss like the sound of a rifle ball. As soon as it touches the earth it springs up and makes a succession of leaps, each less than the preceding, until it finally stops. In fact, it skims over the ground exactly as a flat stone skims over the water.

CURIOUS CUSTOMS

There is a curious custom among the Papuans of New Caledonia. When two people meet they exchange their *katas* (or little scarfs), in the same matter-of-fact way that we shake hands. A New Caledonian also drinks in a very odd fashion. He does not lap up the water, or carry it to his mouth with his hand, but throws it into his mouth out of the hollow of his palm so recklessly that the greater part of it is splashed over him.

The New Guinea Papuans are great climbers, and their antics among the branches of the trees are wonderful. They will climb and spring from one branch to another almost like monkeys, and indeed, like those animals, when attacked, will take to the trees, where they can defend themselves with the greatest chance of success.

THE POLYNESIANS

THE Polynesians inhabit the South Sea Islands and New Zealand. Strange as it may seem, these uncivilized people belong to the Caucasian or white race, as is shown by

CARVED WOODEN DISH FROM HAWAII

their well-shaped Caucasic features. They have been called one of the finest races in the whole world. Visitors to Samoa, Tahiti, and the Tonga or Friendly Islands have spoken of the handsome, well-built, and splendid-looking natives, so similar in type to Europeans. They are clean and tidy in habits, with a sense of order and neatness seldom found among barbarous peoples. They are hospitable, courteous, and honest. Robert Louis Stevenson, the famous author, who lived on the island of Samoa for several years, was very much attached to his Samoan friends.

Most of the Polynesians have been converted to Christianity. It is said that everyone on the Tonga Islands can write; and this is doubtless true, since the missionaries, as we know, always bring to the natives education as well as religion.

SPIRITS EVERYWHERE

It is impossible not to feel interested in a people who were accustomed to think of themselves as surrounded by unseen forces, who saw in the rising sun, the silver moon, a shooting star, the meteor's transient flame, the ocean's roar, the tempest's blast, or the evening's breeze the movements of mighty spirits. The mountain summit and the fleecy mists that hang upon its brow, the rocky defile, the foaming cataract, and the lonely dell were all regarded

as the abode or resort of these invisible beings. The moon in an eclipse was under the control of some evil spirit, and prayers were offered up in the temples for its release. Others believed that the moon had been swallowed by the angry god which it had offended. Then many more must be the presents offered to persuade the angry god to abate his anger and eject the orb of night (or of day, for the same thing happened if the sun was eclipsed) from its stomach.

IDOLS OF OTHER DAYS

In addition to all these deities there were certain spirits who were supposed to be half human and half divine. These spirits were mostly demons, who often became angry and would not be calmed without the aid of the priests. The images of the gods were very crude, made out of rough, unpolished logs wrapped in many cloths, and bound with a finely braided network of cocoanut work ornamented with red feathers. Into these images the gods at certain seasons were supposed to enter; and though the images were among their most sacred things, yet after the gods had departed out of them they were comparatively powerless in themselves. Some of the Polynesians reverenced lizards, others sharks and various kinds of birds, usually in the belief that the gods entered the bodies of these animals.

SURF SWIMMING BY THE POLYNESIANS

Men, women, and children in Polynesia spend much of their time in the sea, diving, swimming, bathing, and sporting in the foam of the surf and great breakers which roll in upon the coral strands of these islands. The wilder the sea the more are they in their element. They usually select the openings in the reefs or entrances of some of the bays for their sport, where the long, heavy billows of the ocean roll in unbroken grandeur upon the reef or shore. They use a small board, swim quite a distance from the beach, sometimes nearly a mile, watch the swell of the wave, and when it reaches them, resting their bosom on the short, flat-pointed board, they mount on its summit, and amid the foam and spray ride on the crest of the wave to the shore. When they approach the shore they slide off the board, which they grasp with the hand, and either fall behind the wave or plunge towards the deep, and allow it to pass over their head. Sometimes they are thrown with violence upon the beach or among the rocks on the edge of the reef. So much at home, however, do they feel in the water, that it is seldom any accident occurs. Often from fifty to a hundred persons, of all ages, may be seen sporting like so many porpoises in the surf, while by their shouting they make more noise than the roaring of the sea or the dashing of the waves.

This shouting has sometimes a purpose, to frighten away sharks, which are the one great danger of this fascinating sport. But sometimes they are not so easily scared off. The cry of *mao*, or shark, is the most terrible sound that a swimmer can hear, and many a gay party has been broken up by this call.

ATHLETIC GAMES AMONG THE POLYNESIANS

Athletic games are popular with the Polynesians. Skillful wrestlers obtain great honor and renown over a long stretch of island-dotted sea, though champions are not long permitted to enjoy their position undisputed, for if it is once known that a visiting chief from a distant island has a celebrated wrestler in his train, the hero is speedily challenged to trials of skill.

Boxing was an equally popular amusement in former times; even chiefs and priests were ranked among the most eminent patrons and champions. Foot races, in which the bodies of the runners were anointed with oil and their heads bound round with garlands of flowers, were also common amusements; while the martial games of throwing the spear or javelin at an opponent who skillfully caught it in his hand or parried the thrust with his spear handle, throwing stones from slings, archery, and mock naval or military combats, were indulged in by young and middle-aged men of all classes. Lighter games were football and ball throwing.

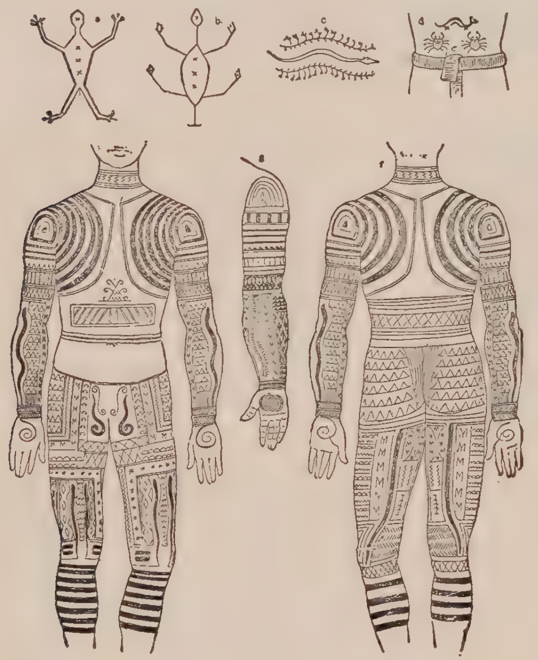
"SEIZING THE BALL."

In these amusements the girls were not neglected. For them there was a game of *haru raa puu*, or "seizing the ball," in which the men took no part. An open place was necessary

PEOPLE AND IMPLEMENTS OF THE PACIFIC ISLANDS

1. Necklaces and ornaments, Friendly Islands and Hawaii. 2. Men of Pelew and Yap, Caroline Islands. 3. Fuzzy-haired type. 4. Koto negro, quaint hair shaving. 5. Bows and arrows from New Guinea. 6. Soudanese negro. 7. Zander. 8, 9. Curious hair dressing of men. 10. Clubs and weapons, Solomon Islands.

for all their sports, and the sea beach was usually selected. The boundary mark of each party was fixed by a stone on the beach, or some other object on the shore, having a space of fifty or one hundred yards between. The ball was a large roll or bundle of the tough stalks of the



AN ARTISTICALLY TATTOOED MAN

plantain leaves, twisted closely and firmly together. The players began in the center of the space; one party, seizing the ball, endeavored to throw it over the boundary mark of the other. As soon as it was thrown, both parties started after it, and, in stopping to seize it, a scramble often ensued. As the game progressed, the players frequently fell over one another in the greatest confusion, and in the general disorder arms or legs were sometimes broken. As the pastime was usually followed on the beach the ball was often thrown into the sea, where it was fearlessly followed. Amidst noise and cheering forty or fifty girls might be sometimes seen up to their knees or their waists, splashing and plunging in the water.

Dances of many kinds, performed in quaint dresses, to the sound of drum and flute, were a favorite recreation. Many games, such as archery, were held sacred. Before indulging in them the performers went to the temple to procure the favor of the gods by religious ceremonies. The king and the great chiefs usually attended a game of archery. As soon as it was over, the bow and the quiver of arrows, wrapped in cloth and held sacred, were committed to the charge of a special custodian. The archers repaired to the temple, and were obliged to change their dress and bathe before taking refreshment or entering their dwellings.

MUSIC AMONG THE POLYNESIANS

Musical instruments of a rude type are common, particularly drums and flutes, which are in great request at high festivals. Trumpets made of shells were used to summon combatants to battle, to blow when a procession walked to the temple, when a king was inaugurated, or during religious services. The sound is dismal and monotonous beyond imagination. These light-hearted people are also much given to singing. They have composed a surprisingly large number of songs, often sad and rather pretty.

TATTOOING

Tattooing is in great favor among all the principal groups of the South Sea Islanders, more especially among the Marquesans and New Zealanders. It is usually adopted as a personal ornament, although the tattoo may occasionally be looked upon as a badge of mourning, or a memento of a departed friend.

Tattooing was supposed to be invented by the gods. Two special deities were the gods of tattooing, and their images were kept in the temples of the professional tattooers, where petitions were offered that the figures might be handsome, striking, and successful.

The painful operation is performed in this fashion: A thread is drawn through the skin with a needle made of fishbone. The skin being punctured, a black coloring matter is injected with other instruments. To show signs of suffering under the operation is looked upon as disgraceful, and accordingly, in some of the islands, a young man who is being tattooed will lay his head on the lap of his sister, or of some young relative, while a number of female

friends will keep up a song, so as to drown the murmuring which the torture may accidentally draw from him.

POLYNESIAN HOUSES

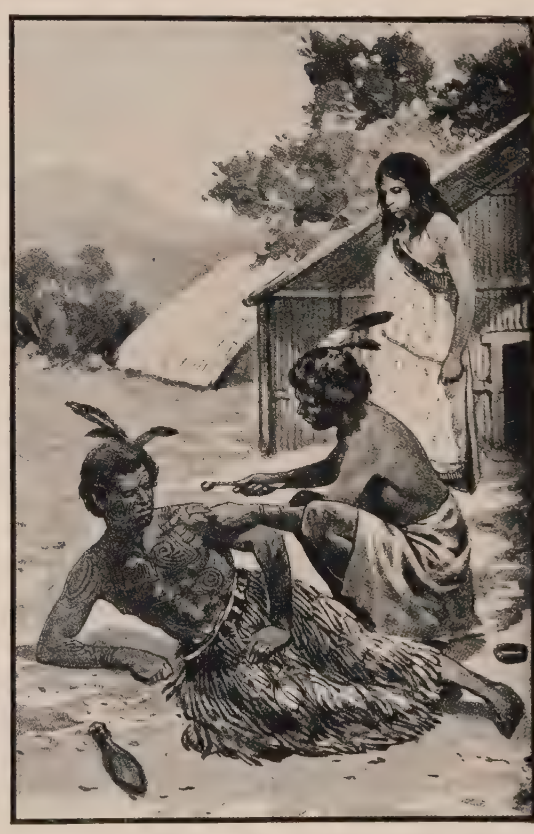
The houses of the Polynesians are usually oblong structures, round at either end. Those of the New Zealanders are finer than the dwellings of their cousins in the Pacific, showing the elaborate and intricate carving in which they are so skilled. Even the common domestic tools of the New Zealanders are richly carved.

The houses of the Samoans look at a distance, as they appear in sketches, like large mushrooms, consisting simply of a thatch of the leaves of the sugar cane supported on three or four long upright posts, the place of the walls being supplied by a piece of matting drawn round the posts. The floor is a hard pavement of gravel, and the general living room is divided into sleeping rooms at night by partitions of cloth.

When the Samoan goes to bed, he places his head on what we should consider a hard pillow. It is a sort of stool, consisting of a carved piece of wood resting on four legs.

THE POLYNESIANS AN INGENIOUS PEOPLE

Take them as a whole the Polynesians are a very ingenious people. A well-known voyager — Dr. Pickering — speaking of the Tahitians remarked that he had never seen a people so serviceable to the traveler, for they seemed able to provide at all times the principal conveniences of life. "Half an hour of daylight was sufficient for building a house of the stems and leaves of the *fehi* banana, and fire was produced by rubbing sticks. In one place the running water was deeply sunk among the stones, but by working in banana leaves they brought it to the surface. The capture of eels, which in these dripping mountains become almost amphibious, offered another instance of their ingenuity. They also tore off with their teeth the fibrous bark of the *purau*, and a moment after applied it to noosing small fish. If one was sent for fruit, he would usually make a basket on the way, by plaiting the segments of a cocoanut leaf. A mat was manufactured with almost equal ease. Clothing was always at hand, and a banana leaf served for an umbrella; or, in fine weather, they would weave garlands of flowers. Tumblers and bottles were supplied by single joints of the bamboo, and casks or baskets by the long stems; and whether we asked for a hatchet, knife, spoon, tooth brush, or wash basin, we never found our guides at fault."



THE TATTOO ARTIST AT WORK

THE WORLD-WANDERING GYPSIES

ON a summer's day, when you have been traveling along a quiet, shady road, perhaps you have come upon a strange-looking camping party. The tents were low, and instead of running up to a pointed roof as our tents do they were probably round-topped. Then if you looked farther you may have seen a big wagon, or cart, with the same kind of top. And near the tents was a tripod — three poles, spread at the bottom and fastened together at

the top — with a kettle hanging down in the middle and a fire underneath it.

Of course you guessed at once that this was a gypsy encampment, and if you also caught a glimpse of the gypsies themselves you became much excited. The women wore red or yellow kerchiefs on their heads and bright-colored plaid shawls over their shoulders. The men wore slouch hats, earrings, and velveteen coats with steel buttons. And all were black-eyed and dark-skinned, with that queer, unmistakable look that gypsies always have. Perhaps you also noticed a weather-beaten, ugly old woman smoking a pipe — the grandmother and fortune teller of the band. Gypsy grandmothers are much feared and respected by their children and grandchildren, and it is well to gain their favor if you wish to see the inside of a gypsy tent.

Gypsies have always been a mysterious and fascinating race. They have no settled home, but roam about the world wherever their fancy takes them. Bands of them have traveled through all the countries of Europe and many have come to America. There is a wild strain in the gypsy blood that delights in the freedom of the open road, and dislikes nothing so much as dwelling between the four walls of a house. Of course during the winter they go into the towns and become house dwellers, but with the first spring sunshine comes the longing to be off on the road.

WHO THE GYPSIES ARE

Who are the gypsies? They are really Hindus, or natives of India, having first appeared in Europe about 1320. Gradually they were dispersed over the different countries of Europe, partly because of the severe laws that were passed against them. In each country they were known under a different name. The English thought them Egyptians, and named them "gypsies," as they probably reached Britain by way of the Mediterranean from Egypt. These wanderers became nationalized to a certain extent in the countries in which they took up their abode. Thus English gypsies are a very distinct class from the continental gypsies, and when they migrate they always go to an English-speaking country. There are certain well-known families of English gypsies who long ago adopted the surnames of Stanley, Lee, Cooper, Boswell, and Lovell, and we meet many of their descendants in America. In former times we heard of "gypsy kings" and "gypsy queens" ruling over the various bands of wanderers, but these romantic beings have now quite passed out of gypsy life. The most famous name in the gypsy annals is that of John Bunyan, the author of "Pilgrim's Progress," who is said to have been the son of a gypsy tinker.

OCCUPATIONS AND CUSTOMS

The English gypsies follow certain distinct lines of occupation. They are chiefly tinkers, horse traders, basket makers, or peddlers, and most of the women are adept at fortune telling, to say nothing of begging. They have generally a bad reputation for taking anything they can lay their hands upon, whether it be a horse or a chicken, as they move from place to place. Their friends, however, tell us that they have a deep sense of gratitude for kindnesses shown them, and rarely betray a trust.

At country fairs the gypsies are always at the front, driving a flourishing business in toys and small wares, and trading horses. Indeed, the gypsy is the shrewdest judge of horseflesh that can be imagined, and one who would beat him at a horse trade must be extremely clever. Gypsies have been known to grow very wealthy in horse trading and other employments. These wealthy members of the tribe have their vans and tents luxuriously furnished with carpets, blankets, linen, and silver, and silk gowns and jewels are not unknown among their families.

LANGUAGE

The gypsies have a distinct language of their own called Romany, which they guard jealously from the "gentiles," as they term people of other races. They pride themselves on the supposed fact that only persons of their own blood can speak this ancient tongue, handed down through many years from father to son. Yet many of their modern descendants can speak hardly a word of it, while various "gen-

POLYNESIAN WEAPONS, BREASTPLATES AND WAR GODS

tile" scholars have completely mastered it. A gypsy has the greatest respect for an outsider who understands his language, and is sorely puzzled to know how he came by it. To be able to *rakker the jib*, however little, is often the passport to an invitation to his tent. He suspects that the stranger is a "gentleman" of gypsy blood and is delighted accordingly. To such a person he applies the term "Romany Rye," or "gypsy gentleman." A student of gypsy history and writer of gypsy romances was George Henry Borrow, whose "Romany Rye" is one of the great stories. An American writer, Charles Leland ("Hans Breitmann"), was a celebrated Romany scholar and a great friend of the gypsies. He has written some entertaining books about them.

The gypsy's own word for himself is "Rom" ("man"). A few Romany words have even crept into the English slang, such as the word "pal," which means "brother."

The gypsies are a decidedly musical race. We have all heard of the weird music of the Hungarian gypsies. Russian gypsies, however, have perhaps the most wonderful musical gifts, which have been in great demand among the upper classes of Russian society. The music performed by these Russian gypsies has been described as the most exquisite and enthralling in the world. Many Russian gypsies are highly educated, handsome, and accomplished.

MISREPRESENTATIONS OF THE GYPSIES

A great deal has been said and written about the gypsies, much of which is not true. For instance, they have been declared to have a habit of kidnaping children; but those who know the gypsies well say that they have no taste for this sort of thieving. They have enough to do to look after and support their own children. Simply because they lead a roving, vagrant life they have been unjustly blamed for numerous cases of lost, strayed, or stolen children, and many imaginative writers have in their stories and plays turned the gypsies into kidnapers.

Do you know how many famous operas have been founded in part on gypsy life and characters? These operas are "The Bohemian Girl," "Carmen," "Maritana," "Mignon," and "Manru." Very romantic are the pictures they present, but by no means wholly true to life.

MODELS FOR MODERN HAIRDRESSERS

BEDOUINS

ANOTHER WANDERING TRIBE

THERE is another wandering tribe different from the gypsies, yet like them in some ways. It is the Bedouins. But instead of wandering over all the world, they stay in their own country, and that is the Arabian desert.

The Bedouin is an Arab, but not all Arabs are Bedouins. The word "Bedouin" means "dweller in tents," and the Bedouin of to-day is a wanderer, or nomad of the desert, having for his home only a black tent made of goats' hair, the material for which is collected, spun, and woven by the women of his family. An Arab who lives in a house looks down upon a Bedouin, but a Bedouin feels insulted if one calls him a house dweller.

The Bedouins have no form of government, except that each family or tribe is ruled by a chief, called a sheik, who settles any difficulties that may arise. They have queer notions of hospitality. They will rob a traveler on the desert, taking even the clothes he wears, and then will invite him into their tents for refreshments. But if the traveler takes food or "eats salt" with them first, they will not rob him afterwards.

The Bedouin women are very fond of jewelry. They wear headdresses, necklaces, nose rings, earrings, bracelets, and anklets of gold and silver. In fact, the Bedouin wealth consists

chiefly in jewels and ornaments. There are no savings banks in the desert, and all the valuables these people can get hold of, are hoarded and hidden.

The desert is not, as one might think, a level, sandy plain. It is a wild wilderness of mountains and valleys, ever changing with the changing winds. Sometimes the sand is of a chalky whiteness; again it sparkles with mica and quartz, and again it is a golden yellow.

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A NIGHT IN A SHEIK'S TENT IN THE WILDERNESS

The second man on the right is the Sheik. A European guest is unusual in this region east of the Dead Sea, and it was only through the courtesy of a man who had been made a blood-brother of the Bedouin tribe that the photographer was able to take this flashlight of a remarkable group. A Nubian slave at the left is pounding coffee, just roasted. Boiled in one of the long-spouted pots, it is thick and black, and is served in little white cups.

A CARAVAN ENCAMPMENT ON THE ARABIAN DESERT

The poet Story has described a desert scene in very beautiful words. He says:

"All around
To the bound
Of the vast horizon's round,
All sand, sand, sand,
All burning, glaring sand.

"Not a sound
All around
Save the padded heat and bound
Of the camel on the sand,
Of the feet of the camel on the sand.

"Not a bird is in the air,
Though the sun with burning stare
Is prying everywhere,
O'er the yellow, thirsty desert, so desolately grand."

And over this great highway of the camel the Bedouin is constantly traveling from one oasis to another, with no guide but the sun and stars, and sometimes with no companion but his beautiful Arabian horse, for on the Arabian desert are raised the most beautiful horses in the world.

The Bedouin leads a very simple life. His chief food is coarse bread and dates. If a Bedouin required as much food as an American or a European, you might wonder how he would ever get enough to eat in the desert. But if you can realize how little it really takes to keep him alive you will not wonder that he can live in the desert or anywhere. What do you imagine he eats through the day on a long desert journey? He takes a double handful of barley flour and mixes with it a little salt and water. Then he digs a hole in the sand, throws in a few sticks and dried vines, and lights a fire. When this small oven is heated, he takes out the fire and spreads his paste on the hot coals, leaving it there until it is thoroughly dry. Then he takes it out, knocks off the ashes, and eats it as his one meal for the twenty-four hours. And yet these men are strong, muscular, and powerfully built. Indeed, the Arab is one of the finest specimens of physical manhood found anywhere.

Meat is seldom eaten by the dwellers in the desert — only when the killing of an animal is done as a sacrifice. Then the blood is poured out on the ground as an offering to Allah, who gives life, and the flesh is eaten as an act of worship. A lamb or kid is sometimes killed and eaten in honor of a guest, or at some celebration, like a wedding.

The Bedouins are Mohammedans in their faith, and most of them are very religious outwardly. Four times a day — at daybreak, noon, sunset, and two hours later — the Moslem priests chant a prayer from the minarets, and at the same hour, wherever the Bedouin may be, he prostrates himself towards Mecca and says his Moslem prayer.

THE ESKIMO

THE Eskimo belongs to the coast and the sea. He lives by the sea. It gives him all the necessaries of his life. Over it he makes all his journeys, in his skin canoe in summer and in his dog sledge in winter.

The Eskimos live chiefly in Greenland, the islands of the Arctic Ocean, and Alaska. As a rule they are not tall, but they have broad shoulders, strong, muscular arms, and a good chest. Their complexion is a brownish yellow, but would be lighter colored if it were kept clean. A visitor once tried to Americanize a little Eskimo girl named Kimnaloo. She brought her a pretty red dress, and then washed her greasy brown skin with soap and water. Layer after layer of dirt came off, until at last she found a clear, smooth skin, with cheeks as red as a rose.

HIS BOAT

When a boy is ten years old he is taught to use the kayak, or fishing boat. This is a craft from sixteen to twenty feet long, and never more than twenty inches broad. It is made of

ESKIMO WOMEN AND CHILD: THEY DO NOT FEAR BELOW-ZERO WEATHER

as many as sixty wooden or bone spars and laths fastened together. A sealskin covering is fastened over the whole top, except a round opening in the middle. In this the paddler sits, and can button it round himself with the waterproof fur so close that no water can get in. Without ballast or keel the kayak draws hardly any water, and in it the kayak-man ventures out into a sea which would smash an ordinary boat to bits. An expert kayak-man knows how to right himself after capsizing. If he is capsized, he is on even keel in a moment, and can play like a sea bird with the waves, and cut right through them. If the sea is heavy, he lays the broad side of his kayak to it, holds the paddle flat out on the windward side, pressing it against the deck, leans forward, and lets the wave roll over him. Or else he throws himself on his side towards it, resting on the flat paddle, and rights himself again when it has passed. Sometimes the fishermen think it is safer to capsize on purpose, and receive the heavy billow on the bottom of the kayak; then when the wave has passed right themselves again.

HIS SLEDGE AND DOGS

The sledge is quite as important to the Eskimo as the canoe. It is made of two runners, usually from the jaw bone of a whale, connected by a number of cross pieces on which the driver can sit and the goods be packed. It is drawn by a team of dogs, varying from five to ten, or even more. They are very simply harnessed to it by a strong cord, or trace, made of sealskin, the trace of the leading dog being much longer than that of any of the others. These dogs are guided, not by reins, but by a whip, the lash of which is from eighteen to thirty feet in length, and the handle only one foot long. A skillful driver seldom uses the whip, but guides partly by his voice and partly by flinging the lash of the whip on one side or the other of the leader, who perfectly understands the signal. When the dogs are required to stop, the driver gives a cry very much like the "whoa" of our own country.

Like anything worth doing, the art of driving these dogs has to be learned. For instance, when a dog team is harnessed up to a sledge, every dog does not pull his hardest, and a suggestion from the whip is needed. If struck, however, the dog gets cross, and at once bites his neighbor. The neighbor in turn bites the next dog, who does the same thing, until the whole team is affected, and every dog is howling and snapping and jumping over the others. When quiet is restored the driver has to set to work to untangle the harness, which gets into a terrible snarl. By this time he has learned that it is better to crack the whip over, instead of on, the back of a lazy dog.

The Eskimos are skillful hunters. Seals, reindeer, walruses, and whales supply most of their needs. The seal is the most important. Its flesh is the staple food, its blubber, or fat, supplies fuel for the lamps, both for light and heat, and its skin is used for many purposes. Before the Eskimos came in contact with civilized people they were entirely dependent on the animal kingdom for food and clothing, and indeed for a large part of their weapons and tools.

In a country where the thermometer is many degrees below zero for months at a time, it is plain that no trees can grow and that wooden houses are out of the question. But this does not trouble the Eskimo, for he builds his igloo, or house, and a very comfortable one, of such material as he finds, and he finds nothing but ice and snow. He saws out blocks of ice and piles it up in a dome-like shape, cementing the pieces together with snow. A large bowl filled with blubber and a wick made of moss serve as a lamp.

LAPPS, THE SMALLEST PEOPLE IN EUROPE

IN the northern part of Norway, Sweden, and Russia, lying wholly in the Arctic zone, is a little country called Lapland. The people who live there are called Laplanders, or Lapps. They used to be spoken of as dwarfs, but this is not quite correct, as they are about five feet tall. They are, however, the shortest people in Europe. One queer thing about them is that they have very short arms and legs and long bodies. They have the low forehead, high cheekbones, and flat features of the Mongolian race, to which they belong.

A LAPLANDER AND HIS FAMILY AT HOME

You can imagine the kind of clothing people would wear in a country that is always cold. In the winter the Lapps wear suits of reindeer skin with the hairy side turned in; in summer, woolen shirts and tight-fitting trousers of reindeer skin. The women are dressed in a single, long woolen garment; those who live near the shore or mingle with the northern Europeans wear undergarments and trim their dresses with bright colors.

The dwellings of the Lapps are very simple. Those who lead a wandering life dwell in tents made of coarse woolen cloth stretched over a frame of poles. Fortunately the cloth is loosely woven, and so allows a little ventilation, for in these tents the Lapps and their dogs all live together as one family. Those who are contented to stay in one place build huts of logs, often covered with earth and decorated with branches of trees. In appearance they are something like the igloos of the Eskimos.

The Lapps have a hard struggle to get their living in the dreary land in which they live, but they have great endurance, and are often happier and more contented in their simple life than many another class of people with greater luxuries. They hunt for wild animals, raise deer, and catch fish. The reindeer furnish them milk, from which they make quantities of cheese.

THEIR PECULIAR BELIEFS

Many of the Lapps are now Lutheran or Orthodox Christians, but they carry some of their old beliefs over into the new. For instance, they believe that the life after death is just the same as the present life, and that they must prepare for it. So money and other treasures are often saved up and hidden away. By keeping the hiding place a secret until his death, the owner thinks that he can use the money in the next world.

CHINESE TYPES, FROM THE LAND WHERE AGE IS VENERATED

OTHER PEOPLES OF THE WORLD

CHINESE, JAPANESE, INDIANS, FILIPINOS, AND SOME EUROPEANS

THE peculiar interest of the peoples of whom we have been speaking has been their simplicity of life. Hunters, wandering tribes, fishermen, and tillers of the soil, they stand to us as types of a primitive mode of life and thought out of which the modern world has long ago passed. Yet it is significant that of the four great divisions of mankind — the black, yellow, red, and white peoples — each has its group of simple, uncivilized tribes, who have not been swept along in the swift current of civilization. Stranded in the remote corners of the world, shut in by forests, mountains, or deserts, they have been left behind by brothers and sisters of their own color and kind.

Now we turn to other peoples whom it is even more important that we know. These nations are interesting because with us they make up the great modern world, all of whose peoples are rapidly being brought, by commerce, easy means of communication, and travel, into one great family. Their names may be in your newspaper any day. Indeed, if you begin to watch the foreign news items you will be surprised to see how many of these world neighbors of ours are mentioned from day to day.

TYPES AND COSTUMES OF INDIA, WHERE CASTE IS SUPREME

THE CHANGING CHINESE

CHINA is the country on the opposite side of the world from ourselves. We say "through to China" as the limit of the land we own. And in the same way many customs and ways of the people of this far-off land are exactly opposite to ours.

The Chinese are for many reasons the people we are most interested in at the present time. They are both the oldest people in the world and the newest. Within our own time the Chinese have looked down on all foreigners as "Western barbarians," counting us as new and uncultured races; and not without some right, for the civilization of China was old when our ancestors in Britain and Germany were rude barbarians. Yet within a few years China has opened its doors to Western civilization, and is taking on new ways with a speed at which the whole world stands amazed.

WHAT THEY ARE LIKE

The Chinese are members of the Mongol race. They are well built but rather short, with yellowish, dark complexion, coarse black hair, narrow, slanting black eyes, short, flat noses, and rather thick lips. The yellow man has a firmer hold on life than the white. He is wonderfully tough, and able to endure hardship and exposure and to withstand bad conditions more successfully than any of the Caucasian peoples. Poverty has compelled crowding and the use of bad food and living in foul air. The Chinese have met these conditions, and those who have lived to grow up under them have a surprising power to work. Patient, persevering industry is one of their most striking characteristics. Of this the Chinese farmer is the best example. China is an agricultural country. Everywhere the common people are landowners, but the plots of ground which they own and till are so tiny that to obtain the barest necessities of life they must practice what we in this country are calling "intensive farming." In the best regions every handful of earth has been almost literally passed through the hands of its cultivators, every leaf inspected, every inch watered and manured, watched and cared for, like a house garden. The result is a land fertile beyond comparison, and a cultivation of the soil that has permitted no waste places. All this farming, as everything else in the empire, has been done in accordance with the ways of the past. Until recently the farming implements have been the same as those used five hundred or a thousand years ago, and even now the small farmers are slow to make changes. Disinclination to change is one of the instincts of the Chinese temperament.

It seems to us, who see the Chinese as foreigners in our streets, that they are very serious. They are naturally reserved and earnest, but at home they are bright and cheerful. They are forever laughing, playing tricks, making fun, and exchanging wit. Those who come to know them find them human and likable. Smile at them, and a smile comes back. Their quick temper leads to many family quarrels, which they take no pains to hide from the public. They are always polite and keen to acquire good manners and refined ways. Indeed, politeness is to them far more than a mere code of manners. It is a system handed down by tradition and so perfected as to be almost a religion. Confucius, their great teacher, said, "All virtues have their source in etiquette." There are ceremonials for every social relation, and rules for every possible occasion. Those who know the Chinese best, including foreigners who trade with them, give them a very high character for honesty and fair dealing, as well as for peaceableness and kindliness.

THEIR DRESS

Their dress has remained the same, generally speaking, for centuries. Garments of fur or velvet or silk are handed down from parent to child for two, three, or more generations, and there is no reproach attached to wearing a garment eighty or ninety years old. Clothes are largely made of cloth and silk, furs and skin being worn in winter. A finely dressed gentleman of the wealthy class might easily have on clothing costing fifteen hundred dollars. The costume consists of inner and outer tunics made of cotton or silk, sometimes short, sometimes reaching to the feet, and with wide sleeves extending below the hands and suitable as pockets. The Chinaman never "pockets" anything, as an American does. He actually "sleeves" it.

A CHINESE FAMILY OF MEANS IN THE HOME COURTYARD

The dress is completed by loose trousers covered to the knee with cloth stockings, tight leggings being pulled over both in winter. Quilted cotton garments are very common, and so made as to protect the whole person from cold and obviate the need of fires.

The women are described as the most completely and modestly dressed of any women in the world. Their two garments cover them without interfering with their ease in movement, and their girls work and play as freely as boys.

ODD CUSTOMS

For centuries Chinamen wore their hair long and bound upon the top of the head. But two and a half centuries ago the Manchu Tartars invaded China from the north, conquered it, and elected their chief emperor. The Manchus, who wore their hair in a queue, or "long tail," forced their Chinese subjects to adopt this style of hair-dressing, and a long, thick queue was, until the recent edict, a point of pride with every honest Chinaman. Long nails have been fashionable, especially among the educated classes, and often necessitate nail protectors. Of course one can hardly do much work with long nails.

Perhaps the queerest and most barbarous custom among the Chinese has been that of foot-binding. Young girls of the better classes have had their feet bound tightly in early infancy, the four small toes being tucked under the sole, of which after a time they become a part. When the painful process is complete the Chinese lady has what has been considered a mark of great beauty and elegance — a queer, deformed little foot which will fit into a shoe three and a half inches long. The Chinese lady does not walk; she totters or hops. But then it is not considered good form for her to go on foot very much. She is usually carried about in a sedan chair. The younger generation of Chinese who have helped to establish the republic are doing away with this foolish and cruel habit of foot-binding. Even now it is not by any means a universal custom. The Manchus, the conquerors of China, have never practiced it, and it has not been allowed in the palace; and of course Chinese fathers and

mothers who have become Christians do not allow their little girls to be so crippled. But time must be allowed for a custom which has been observed for nearly a thousand years wholly to die out.

In dress and custom, as in everything else, it must be remembered that the tide has turned in China. Tradition is no longer the supreme law. Within the last few years one custom after another has been done away with or changed among the more educated and advanced classes. In the first constitutional convention, in 1912, nearly all the men were in European dress. It will not be many years, at the present rate of change, before the queue will be regarded as a curiosity. All through China there is a new consciousness of progress, and an eager desire to know how to do things in the best way. The officers of the new republic have most of them been taught in America and England, and are modern in their ideas. The advice of the Americans is sought and prized, as the people are coming into a new national life.

THE IMPORTANCE OF THE FAMILY

The whole political and social organization of the nation rests on the family. The supreme duty of a child is toward his parents. Both Confucius and wise men before him taught that reverence for parents was the greatest virtue that could be practiced. The Chinese have carried this to the extreme of worshiping their dead ancestors. In every house stands a wooden cabinet containing slips of wood called "ancestral tablets," because the Chinese think that the souls of their ancestors live in them. Each one has writing upon it, telling the name of the person whose soul is said to be inside.

Fear mixes with the worship of the dead at every turn. When people are sick or lose money or have some other trouble, they think that the spirits in the tablets are angry and are bringing evil upon their home. They offer food, and burn paper, clothes, houses, money, servants, and horses to please them, thinking that when burnt these things pass into the spirit land, where

A CHINESE DINNER, WITH CHOP SUEY AND THE CHOPSTICKS

their relatives enjoy them, and, being pleased, give up troubling those on earth.

This respect of young people for the past has a beautiful side. The rights of parents are such that every man with grandsons has what is as sure as an old-age pension. Disrespect to his elders would be undreamed of by the Chinese boy.

EDUCATION

Boys are of much more account in China than girls, and so parents are always more pleased when a boy baby is born to them than when the baby proves to be a girl. Formerly it did not matter very much whether a girl received an education or not, while the education of a son was of very great importance; but the position of woman has been much improved under the new order of things. High government positions have always been open to learned men, no matter how humbly born, provided they have been able to pass the examinations held in competition for these positions. Every father, then, is anxious that his son should obtain as much learning as possible, for he knows that education may prove the road to great riches, rank, and power. After learning to read and write the Chinese boy was set to work memorizing some of the old classical literature of China, which was supposed to contain the sum of all wisdom. The more he knew about these classics the more clever and learned he was supposed to be, and the greater was his chance of succeeding should he compete in the government examinations.

But in 1905 a wonderful step in educational reform was taken when the empire started an entirely new system of schools, based on European methods. China could not help seeing that her little neighbor, Japan, although an Asiatic nation like herself, was rapidly becoming a great figure in the councils of the world through her adoption of Western modes of education; and Chinese students who had been sent to Japan to study were bringing back new and revolutionary ideas. As there were no text-books in the new studies — nothing, for instance, that a boy might learn his algebra or geometry from — the government adopted the text-books in use in the schools of the Christian missionaries and written largely by the missionaries themselves. Thus did it pay a tribute to the great work being done by Christianity in China.

The Chinese have a great reverence for written language. Waste printed paper is collected from house to house and burned, to preserve it from profanation. The Chinese writing is a kind of picture writing. It does not represent the sound of the spoken words but gives a kind of picture, or rather symbol, of the idea or thing to be expressed. The number of these words is reckoned at fifty thousand. One of the most striking changes recently made in China is the adoption of an alphabet almost like ours, in place of the present symbols. This phonetic alphabet is being widely taught in schools, colleges, and even village assemblies, and is proving a great success.

CHINA'S MILLIONS

When we talk about China and the Chinese, we must remember that we are talking about the most numerous people on the face of the earth. The republic is second in size only to Russia, and has four hundred millions of people. Travelers who go from one province to another say that they tear up in North China the notes which they made in the south because they find them contradicted. Each province has its own life, its own ways, and its own peoples. China comprises nearly one-fourth of Asia and one-twelfth of the land area of the globe. It is made up of China proper, or the Middle Kingdom, and the dependencies of Mongolia, Manchuria, Tibet, and East Turkestan. In its eighteen provinces speech varies as much as the differences between Portuguese and Spanish, but the written language is the same.

At Shanghai more than at any other port people from all provinces may be seen. The city is situated near the mouth of the Yangtze River, the "garden of China," and has a larger foreign trade than all the other ports together. Tientsin, at the head of sea navigation on the Pei-ho River, is the seaport of Peking and the most important commercial city of northern China. Canton is the great seaport of southern China. It is inclosed by a wall six miles in circumference, and has many temples. A large part of the population live on the river in boats called *sampans*.

Peking, the capital city, has been the residence

of the emperors for over nine hundred years, and is a very interesting city. It is in two grand sections, each surrounded by walls, the southern section called the Chinese City and the northern the Tartar City. Within the latter is a walled region known as the Imperial City, and within this still another walled inclosure, the Forbidden or Sacred City, in which is the imperial palace. Peking has fine shops, theaters, restaurants, palaces, and temples.

The Chinese are a great people, great in numbers and in promise for the future. No other nation has been so true to itself and "preserved its type so unaltered." No nation has developed a civilization so completely its own and independent of outside influence. It has held to its own ideas and preserved its own literature. The secret of this wonderful self-preservation is its constant study of and reverence for the past. As the Chinese come into the modern family of nations, those who know them intimately predict that their future will be even greater than their past.

THE CLEVER JAPANESE

THEIR HOME

LOOK on your map of Asia and you will notice a group of narrow islands lying in a chain off the coast of China, from which they are separated by the Japan Sea. These comprise the ancient island empire of Japan, a little country, but the home of a remarkable race, which in recent years triumphed in war over two immensely larger countries, the mighty empires of China and Russia. The name "Japan" is from Cipangu, a European misspelling of Chi-pen-kue, which is the Chinese name for the country. Marco Polo brought back the first knowledge of this region to Europe in 1295, and with it this name by which the islands were known to their Chinese neighbors. By its own people Japan is called Nippon, an ancient name meaning "Land of the Rising Sun," or oftener Dai Nippon, "Great Land of the Rising Sun."

The Japanese are Mongolian cousins of the Chinese, but with a strain of white blood that has helped to make them a far more progressive people, according to our idea of progress.

Up to 1854 Japan was a very backward little Oriental country, cut off by its laws and customs from all the rest of the world and with a deep scorn and hatred of foreigners. But when Commodore Perry sailed into the harbor of Yokohama one memorable day with a fleet

A JAPANESE JUDGE: A FINE TYPE

of United States war vessels, he frightened the Japanese, and forced them into a treaty opening their ports to the Western world. That waked them up. So fast have they been waking up ever since that they are literally a people "made over," and have become one of the most powerful nations in the world. Go to Japan and you will find the telephone, steam and electric cars, houses heated by steam, public schools, and many other marks of a modern progressive nation. But the old customs which make the Japanese so interesting still continue; and thus we find in them a strange blending of the old and the new.

It is so customary for the Japanese to visit

America nowadays, especially as students, that we can learn much from them concerning their country. A young Japanese artist, Mr. Hiroshi Yoshida, who has visited America several times and exhibited his pictures here, has given some interesting facts about his country and its people from the intimate standpoint of a native. We shall quote some of his statements, since it is fair to let people speak for themselves.

THE JAPANESE AND THEIR OCCUPATIONS

The Japanese are short in stature, with yellowish-brown skin, prominent cheekbones, slightly oblique eyes, and straight black hair. They are highly intelligent and quick-witted, and have shown in their wars with China and Russia that they have powers of bravery and endurance unsurpassed by any other race. Although quick-tempered and sensitive in small matters, they are an extremely courteous people. From babyhood they are all taught to be most gentle and polite. To be rude or to talk loud is considered a serious fault.

There is a great deal of real home life among the Japanese. Family ties are very strong. Children are always in the care of their mothers and are seldom given to the care of servants. So, as a child grows older, it shares all the hopes and interests of its parents. Obedience to parents is a very strict law. Even a married son obeys his mother as long as the latter lives, although he may have children of his own.

Nowhere will you find a more frugal and industrious race; and indeed they are obliged to be in order to support themselves. Here are a very numerous people in a country too small for them; moreover, a good deal of it is mountainous. So they have to make the fullest use of all their fertile lands, every little plot being diligently cultivated. Their farms are models of order and neatness. The chief agricultural products are rice (the staple of the country), tobacco, tea, maize, wheat, and barley. There are not many cattle in Japan, as grazing lands are scarce.

One of the important industries is fishing, fish and rice being the staple food. The waters of the Japan coast fairly teem with fish of every variety, including some found in no other part of the world, and they afford a means of livelihood to many hundreds of fishermen.

Helpless people are not numerous in Japan. The blind, for instance, have two professions that no other people can enter. If they have an ear for music they are taught that from earliest childhood, or if they have no musical taste they are instructed in massage. The blind boys especially become masseurs or shampooers and are the most skillful in the world. In Japan only girls of the poorer classes go outside their own homes to work. These girls become workers in the fields; they also weave silk on the hand looms, clean rice, and spin. Many girls are hairdressers, and go from house to house arranging the hair of all the women in the household. The charge for this service is very small, about two cents, and the hair, when once arranged, keeps its own place, and has to be done over again only once in two or three days. The girls and women sleep on hard little pillows, shaped with a hollow to allow the head to rest without disturbing the hair. Men, however, are more comfortable on soft pillows.

A LAND OF FASCINATING SIGHTS

The Japanese, with their industry and wonderful artistic taste, have turned their country into a beautifully kept garden. And what a flowery kingdom Nature has given them! Chrysanthemums, irises, peonies, cherry and plum blossoms in their season, make the fields visions of loveliness; and with the many shrines and temples scattered throughout the land, what wonder that it presents a fascinating picture to foreigners?

To the stranger everything in Japan appears quaint and curious, almost elfish. As you glance down a city street you see blue everywhere; houses have blue roofs; shop fronts are hung with blue; the people have more blue in their costumes than any other color. The shops are low and light, with their first stories open to the street, and there is an endless flutter of flags and dark blue drapery. The floors of the tiny shops are well raised above the level of the street and covered with matting. The dark blue blouses of the laboring men are adorned on the back with curious

A JAPANESE FAMILY AT HOME

These are typical faces, and the scene is characteristic throughout. The dainty dress is something to be not only admired but imitated. Fishing from the home piazza makes sport convenient. The Japanese love the country and simple life. As the picture shows, the houses are built very light, and seem frail.

letters, a sort of trademark, making known the name of some guild or company of which the wearer is a member.

Children are everywhere, the funny-looking Jap babies being carried in hoods on the backs of their sisters or cunning little mothers. Here are two demure little Japanese ladies under a gay paper sunshade, their sleek black hair beautifully dressed, taking an airing in a jinrikisha. Do you know what a jinrikisha is? It is a little carriage or cart, for all the world like a chair on two wheels, and it is drawn by a man, who grasps it by its two handles. It is safer and much cheaper than a horse and carriage. You can hire a jinrikisha man for the whole day for about one American dollar, and he will trot through the streets with you on his straw shoes without seeming to tire himself very much. He can go into small places, where carriages cannot go, and he does not try to run away with you!

HOW THE JAPANESE DRESS

The Japanese native costume has been unchanged for hundreds of years, and is practically the same for men and women. All who can afford it have the *bitomo*, or undergarment of bright silk. Over this are worn two or three and sometimes five or six flowing robes — *kimonos* — of silk or crape. About the waist is worn the *obi*, a wide girdle of satin or heavy silk, tied in a large square bow behind. On the feet are high clods of elmwood or straw sandals, according to the weather. Umbrellas and fans are used by both sexes. The little children are dressed the same as their big brothers and sisters, but in brighter colors. White, instead of black, is the mourning color. For business convenience, many of the Japanese men now wear the European dress, but they do not like it very well and in their own homes put on the native costume.

HOW THE JAPANESE LIVE

The houses are very simple. They consist of one story, and instead of many rooms there is one large floor space which can be divided at will into smaller rooms by means of sliding or folding partitions. In every house in the olden days a special place called the *to konoma* was decorated and reserved for the emperor, should he happen to stop there. Now this room is still set apart, but used also for honored guests. The *to konoma* is somewhat like a mantelpiece, but divided into two parts, one for flower arrangement, where fresh flowers are often placed, and the other for vases and ornaments. In front of this place the oldest guest is always made to sit.

Bedrooms used only to sleep in are not known among the Japanese, for they sleep in all rooms at night. In the morning the pillows and coverings are put into closets out of sight and the entire house is ready for the uses of the day. There is usually a veranda on each house and beyond it an ornamental garden, very attractive with its flowers, stone lanterns, ponds, and dwarf trees. The Japanese are fond of nature, and like to make trips into the country to see the iris fields; or, in the springtime, they enjoy spending an afternoon by the river under the blossoming cherry trees.

Food in Japan is very cheap. Breakfast consists usually of rice and a soup made of vegetables. At noon a light luncheon is served, and at night there is a hearty meal of soup, fish, meat, and *tsukemono*, a kind of salad. Men drink, at night, a little rice wine, but women are not expected to drink anything but tea. Chicken is a favorite dish. When callers arrive during the day, the host or hostess hastens to offer them tea and sweetmeats and all kinds of little cakes. Instead of knives and forks chopsticks of wood or ivory are used. Foreigners who have tried to use the chopsticks have found it a difficult art to master them, and have wondered at the skill of the Japanese.

One of the most popular amusements is the theater, and strangely enough the most popular plays are tragedies. These old tragedies are very long, sometimes occupying four hours in performance. Between the acts the audience rests and eats a luncheon, consisting generally of little sweet cakes and rice cooked in various ways. Afternoon is the favorite time for performances, and the plays are accompanied by music — music which I fear we should think rather odd, being made with some queer Japanese instruments.

EDUCATION

The Japanese, imitating American ideals, now consider public schools indispensable. Even the smallest towns and villages have their schoolhouses. When the people are too poor to build a schoolhouse, they make use of some deserted temple. "The school enrollment," writes an American observer, "is as high as in any but the most advanced European nations, being over ninety-eight per cent of both boys and girls. One result is that nearly every Japanese under thirty years of age can write, and it is common to see the jinrikisha pullers and navvies reading newspapers and novels. It is a very poor school that is not filled to overflowing. Five or even ten times as many men as can be admitted take the stiff entrance examinations for the higher schools. Apprentices and artisans who rise at daybreak and work ten or twelve hours are enrolled by the thousands in evening schools." To this passion for education may be attributed the startling progress in Japan within a generation.

The Japan which has been described in the preceding pages is the old Japan, the picturesque Japan of earlier days. Side by side with those who cherish these customs and follow these ideals is growing up a young generation which is as familiar with modern inventions as our own young people. The airplane, the radio, the moving picture are among the inventions which are tending to unite the world. It is a difficult problem which faces these young people. The old standards are going. Japan watches the Western world to see what shall be put in their place.

ARTISTIC TASTE

The artistic taste of the Japanese is very striking, even their commonest articles being touched with grace and beauty. The simplicity with which they furnish their houses, the care they bestow upon their gardens, the time they spend in the arrangement of flowers, even the dainty little lacquered tables from which they eat their meals (sitting on their heels on the floor), betray the refinement and delicacy of their tastes. For instance, before a Japanese lady is regarded as well educated she must have studied for a year or more a course of lessons in the arrangement of flowers.

The Japanese have a peculiar and delightful style of painting, which is like that of no other race and has become known the world over. They do not produce pictures, but rather "decorations." They treat their subjects

JAPANESE TATTOOING — HIGH ART

in what is called a "flat" style, and with great delicacy of touch. Fishes, insects, and birds they paint to perfection. Yet they could not paint a really human and truthful portrait like the great European masters of painting. Someone has well said, "Japanese art is great in small things, but small in great things." A few of the younger artists, however, among whom is Mr. Yoshida, have begun to paint in our Western, modern way and have produced some very able work. It is to be hoped, however, that they will not give up their native style. In perspective, showing distance with a few strokes, they have no equals.

"THE BEST COUNTRY"

In his article Mr. Yoshida made this quaint and charming comment on his country:

"I cannot help thinking that, after all, we Japanese have the best country in the world. Indeed it is the most beautiful of all with its flowering fields, and its wonderful temples, and its many trees and its noble mountain, Fujiyama, that has snow crowning its peak and flowers growing at its base. Yes, we have all these and all modern advantages besides."

Japan is singularly beautiful in its natural aspects. Its islands form the summit of a remarkable mountain chain that rises from the depths of the ocean. These islands are remarkable for the length of their coast lines. If the area of the islands were compared with the length of the coast line, it is said that there would be one mile of coast line to every nine square miles of land. This varied coast line gives the opportunity for many excellent natural harbors, particularly on the Pacific Coast. The shores abound in fish, which forms one of the main articles of diet of the people.

"The aspects of Nature in Japan," says one writer, "as in most volcanic countries, comprise an amazing variety of savage grandeur, appalling destructiveness, and almost heavenly beauty. From the mountains burst forth volcanic eruptions; from the land come tremblings; from the ocean sweeps in the dreaded tidal wave; over it rages the typhoon." It is a brave people that can dwell in such a land and carry on life serenely and victoriously.

FUJIYAMA

No story of the Japanese could end without a mention of Fujiyama, the highest mountain in Japan, a volcano extinct since 1707, whose slopes rise in long, sweeping lines from base to summit. To the world as well as to the island people themselves Fujiyama stands as the mountain of Japan. Long held sacred by religion and affection, it towers high above other Japanese peaks, and can be seen from more places than any other mountain. Poets have sung of its beauty and artists have drawn its outline till it has become a symbol to the world of the fair lands which it crowns.

PEOPLE OF INDIA

THE Hindus are the chief people of India, that great region of southern Asia whose northern boundary is the range of the Himalaya mountains. The Hindus proper are of Caucasic stock, as is seen by their straight noses and perfectly regular features. They are a dark-skinned people, and often very handsome. Besides these there are two other races in India, Negroes and Mongolians. The civilized Caucasic Hindus, or Aryans, entered India from the north many centuries ago, conquered the black natives, and drove them into the hills.

These Aryan conquerors looked with hatred and scorn on the blacks, and strictly forbade marriage with them. This was the origin of the famous caste system of India, which arose as a matter of color. The blacks were more numerous than their fair Aryan conquerors and would doubtless have absorbed them but for the system of caste. As now known in India, caste is dependent on race, occupation, and religion. The four original castes are: (1) the priests or Brahmans; (2) the warriors; (3) citizens, traders, and agriculturists; (4) the menials or low-grade laborers (sudras). There are of course a great many subdivisions of these four great classes. People of one caste are not allowed to marry into another caste. In some parts of India those who belong to different castes are as far apart from each other as if the lower-caste men were not human beings at all, and a high-caste man will not touch a low-caste one even to save his life. There is also an unfortunate class of people called pariahs, or outcasts, who live on the outskirts of civilization. The term originally meant "hill men."

THE RELIGION OF INDIA

The sacred scriptures of the Hindus are called the Vedas, and they were composed by the early Aryans on their conquering march through the country. A Hindu believes that everything we do in this life is punished or rewarded in another life on earth, and that everything that happens to him in this life is the result of

something he has done in a previous life which he has forgotten. He fears very much to do wrong because he may suffer for it in his next life, or he may be born a cow or a frog or some other animal. Because of this, and because the spirits of his gods may be in trees or in animals or stones, he is very kind to animals and he worships trees and stones. The round of birth or death is very long, for the full number of lives is eight million four hundred thousand, and if, after the soul has made many steps upward, it breaks a rule of life, it may have to go away back to the beginning. The one great hope is that sometime in the dim future, by keeping all the rules of the game in one life after another, the spirit may be set free from birth and death, and may drop out of the endless round.

BRAHMAN FAMILY, THE HIGHEST CASTE IN INDIA

When the hymns of the Vedas were composed, as now known, caste had not been thought of. Great chieftains chose learned men to officiate at religious services. As writing was unknown, those families who learned the hymns by heart became hereditary owners of them, and they proved to be a valuable family property. The powerful prayer was called Brahma, and the man who offered it Brahman. Thus the Brahman or priestly caste grew up. They had the learning and culture, as well as religion, and became the councilors of princes and teachers of the people, forming to-day the highest and most powerful caste in India. They are treated almost as if they were gods, and many of them live by the gifts of the people. They gradually became a class apart because of a distinct mode of living. They learned the sacred scriptures

A HINDU FAMILY OF THE SUDRA OR PEASANT CASTE

and tended the sacred fire. After marrying and bringing up a family, the Brahman retired to the forest and lived in solitude in the performance of religious rites. Finally, as an old man, he became still more separate from the world, such a man as is described by Kipling in "Kim." The Brahmans are an ancient caste, and are said to have been living in much the same fashion since the sixth century before Christ. They still have their colleges and devout students.

FAKIRS

Perhaps the queerest people in India are the Fakirs. They wander about from city to city and from temple to temple, and live on the gifts of the devout. The Fakir wears as few clothes as possible, but he covers his body with mud and ashes and makes his hair stick out in all sorts of uncouth forms with gum and clay. He has a boy whom he calls his "Chela" with him, and a brass bowl, and nothing else. The boy goes out with the bowl at breakfast time and begs till it is full; then he comes back to the Fakir, where he is resting by the temple steps or by the wayside, to eat the meal with him.

Among the Fakirs are men who do wonderful conjuring tricks. Sometimes a Fakir will suddenly appear to climb up into the air, going hand over hand on a rope that is not there, till he vanishes into the sky. In a few minutes he will come quietly along the street as if nothing had happened. Sometimes he will take a mango fruit, open it and lift out the seeds, which he drops into a little tub of earth. As the bystanders watch they see a mango tree grow up and bear fruit before their eyes. Nobody can explain just how the Fakir performs these weird tricks.

BUDDHA AND MOHAMMED

Although Brahmanism is the religion of over two hundred millions of the three hundred millions of India, about sixty millions are Mohammedans. Mohammedanism was founded by Mohammed, an Arabian prophet born at Mecca in the sixth century after Christ. He declared that there was only one God, whom he called "Allah," and that he himself was his prophet. Within his lifetime he conquered Syria, Egypt, and Persia, and before fifty years had passed after his death his followers had marched through the wild passes of the mountains into India. Since then there have been followers of the prophet there, and they have exercised a strong influence upon the Brahmans. Buddha, the greatest religious leader of India, sought to reform the idolatries

and evils of Brahmanism, and while he did not make much impression upon the Hindus of India proper, in Burma he established Buddhism firmly, and from there it spread into China and Japan.

STRANGE CUSTOMS OF THE HINDUS

In another part of this book you read about the Ganges, the sacred river of the Hindus. There is a legend that the Princess Ganga, one of their goddesses, turned herself into this great river many, many years ago, that she might enrich and purify the country. Because of the sacredness of the Ganges men bathe in it and pray to die beside it; and they hope that after their bodies have been burned on its banks the ashes may be scattered over its waters and allowed to float away far out to sea.

Every bend of the Ganges is sacred. Pilgrims walk from its mouth to its source and back again, taking six months for the pilgrimage. If they wish to win more merit they lay themselves down on the ground and cover miles of the bank with their bodies instead of with their feet, and that takes them far longer. Fanatics used also to roll on the ground before the temples when a procession bearing idols was passing, or throw themselves under the Car of Juggernaut, and be killed amid applause, but this is now forbidden by law, as is the burning of widows and throwing of babies into the Ganges.

The most sacred city is Benares, and all the year long its streets and temples and river banks are thronged with pilgrims. They bathe and throw sandalwood, sweets, and flowers into the river.

For a century now the Christian missionaries have been at work in India, and great changes have taken place in the life of the people. Education has brought the knowledge of Western civilization, and the thoughtful Hindus have recognized the value of much of the truth taught and the improvements made in healthful living. India is in a state of political and social unrest. As a part of the British Empire it bore a heroic share in the World War, sending its troops to fight side by side with the British. Now its leaders are standing for and gaining a considerable degree of self-government.

BENARES, INDIA, ON THE SACRED RIVER GANGES

TYPES OF EASTERN PEOPLES OF THE WHITE RACE IN CENTRAL ASIA

MEDITERRANEAN PEOPLES

As we come westward around the globe, we leave behind the yellow Mongolians, whose home is in Central, North, and East Asia, and meet the white or dark Caucasians, who are our own kin. The first we come to, who live on the shores of the Mediterranean, are of a different type from us. Their eyes are dark and bright, their hair is black, wavy or curly, and their color is pale olive or swarthy. Their features are regular and often handsome. They are quick in their movements and bright and responsive mentally.

PERSIANS AND GREEKS

With most of these Mediterranean peoples, the Armenians, Persians, Greeks, Italians, and the Turks, who are farther to the east, we are more or less familiar. The Persians are among the oldest of these peoples. They have behind them a long history of culture, which shows itself in the brilliancy and polished manners of their higher classes. The Persian has been described as an easy-going man, wishing always to make things pleasant and succeeding by his charm of manner and grace of speech. The home life is pleasant. In the family great reverence is shown to the father, whose word is law in the household, but especial devotion is reserved for the mother. Persian ladies are cultivated and delightful, as their husbands are brilliant and clever. But the word most often on a Persian's lips is "to-morrow." Always pleasant, they put things off as long as possible, until the foreigner despairs of ever making a bargain with them or settling an affair.

Across the water are the Greeks, intensely patriotic, democratic in spirit and in social life, quick-witted, hospitable, a kindly, thrifty, beauty-loving race. Along with the virtues of these Southern peoples go the corresponding faults. With all their brilliancy, they are said not to be deep thinkers. They are excitable and unstable, with quick transitions from sunshine to showers and back again, which take the slower-moving Northerner by surprise. Like all these Mediter-

PERSIAN LADIES IN STREET COSTUME

ranean peoples, they are charming to move among, hospitable, cheerful, and courteous.

THE LAWLESS KURDS

Away up in the mountains between Persia and Turkey live the Kurds, a picturesque and exclusive Aryan people. They are a wild, handsome, lawless folk, living in tribes like the Highland clans of Scotland. They are a pastoral people, raising flocks and herds. One group of them, the Yerli, live in villages in winter and encamp on pasture grounds in summer; the others, who are the wealthiest and most independent, always dwell in tents. They spend their summers on the mountains and high plateaus, coming down in winter to the banks of the Tigris, where they buy right of pasturage from the Arabs.

To their Turkish and Persian neighbors the name of Kurd is a byword for lawlessness. Delighting in the liberty of a mountain and wandering life, they pay little heed to the laws of ownership or society. Roving for pasturage, they learn to plunder, and are famous for their raids and massacres, especially on the Armenians, whom they consider their special prey. In some respects these people are inferior to the Bedouins, who always respect the rights of hospitality. The Kurds are treacherous, and often do not hesitate to kill a guest. And yet they have a reputation for honor and loyalty, for it is said that the Shah of Persia trusts them more than any other of his subjects to be his bodyguard.

DODGING THE TAXES

An instance of how they defy all law is shown when the Turkish government has tried to tax them for salt and tobacco. They care little for the law, but less still for its agents. There is a

A GREEK TYPE OF TO-DAY

A VEILED TURKISH LADY

high range of mountains to be overcome before the law can be enforced, and the Kurds carry on a system of smuggling right under the nose of the authorities. But as it is impossible to keep the tax collectors off the tobacco plantations when they are on the plains, the Kurds do their planting only where the mountains are steep enough for defense, the trusty rifles of the sharp-sighted mountaineers keeping the would-be collectors at a distance. When Turkey attempts to reduce them to order, they cross over in a body into Persia. And if Persia undertakes any authority over them, they return to Turkey.

Each chief hires a band of assassins to protect his interests and do away with his enemies at any cost. They have never had any line of rulers or united form of government. They have no literature. In fact, reading and writing are almost unknown to them. They, therefore, have no more history than the wolves and jackals among whom they live.

The sight of a band of roving Kurds, wandering in single file along the edge of a high cliff overlooking a precipice, carries one back in imagination to the days of Abraham. Like the Hebrews, this shepherd people has great pride of ancestry, keeping the records of families back for many generations, and considering themselves, in spite of their wandering life, a race of aristocrats.

A RUSSIAN BELLE AND BRIDE

INDIAN HOLY MAN MOSLEM TURK ARAB SHEIK SINGHALESE MAN

THE UNITED STATES, A MAGNET FOR ALL PEOPLES

Into the description of the European races and nationalities — the Turks and Hungarians, Germans, Scandinavians, Spanish, Italians, Jews, and Swiss, the French, English, Irish, Scotch, and Dutch, and all the rest — it is needless to enter. We do not have to go to these people except to see their beautiful home lands and appreciate better their background of history, for they come to us. America, the land of freedom, is a magnet, drawing all peoples with a strong pull towards itself. Every week the steamers are bringing them by the thousands, and they are settling among us as neighbors and fellow-citizens. There has never been a movement in the history of the world more silent and yet more powerful than this steady mixing of all races and all peoples in our own republic. For a few years they are foreigners in speech and ways, but their children are Americans. The United States is called the world's "melting pot." To us it is given to watch and see what will come out of this great mingling of all the races of the world.

OUR OWN BROWN PEOPLES

SINCE 1898 we do not have to go outside the limits of United States possessions to find a surprising variety of black and brown citizens. Then the Philippine Islands passed from Spain to the United States, and we took under our protection a great mixture of races. The aborigines, or first inhabitants, of these islands were probably the tiny black Negritoes, a short race, like the Pygmies of Africa, who live in the interior of Luzon and Panay. They are nomad peoples with no fixed home, who tattoo them-

A TURKISH PEDDLER

HIGH SCHOOL GROUNDS AND BUILDINGS AT BACOLOD, P. I.

selves and live in all ways like their savage brothers across the world.

Then, as the story of the islands goes, came the Malays, a brown race who still make up a large part of the population.

THE MALAYS

The Malays were once famous pirates of the East. They used to go on long voyages in their shallow one-sailed boats, sometimes because they wished to trade with other tribes, but more often to raid the villages lying along the coast or to rob ships that they met on the high seas, and start colonies, as they did in the Philippine Islands. They came to be known by the peoples living in many parts of the world, though their real home was in the Malay Peninsula.

The Malays belong to the Mongol branch. The race is a highly mixed one, varying in color and habits between one of their homes and another. The Javanese are peaceful, law-abiding citizens, knowing the art of writing and borrowing many of the ways of their more civilized neighbors, while some of the Formosa Malays keep records only by means of knotted strings, and the "wild man of Borneo," who is one of this family, was until lately a head-hunting cannibal.

In the Philippines our soldiers have found all varieties. In Luzon were the Igorrotes, many of whom were head hunters and wild men of a savage type. But now most of these peoples are industrious farmers, as indeed a large proportion of them were before the American occupation. They came in the first great Malay invasion of the Philippines. The tribes whom we have found most troublesome were the Mohammedan Malays of later invasions, from whom are descended the fierce Moros. They have been the Filipinos to stand out against American authority longest and most fiercely; until at last, after constant trouble with them, the government has decided to take away their weapons, thus compelling them to give up their fierce and savage ways and cease to menace all their more peaceable neighbors.

THE AMERICAN OCCUPATION

The United States government is giving this island people an opportunity to learn self-government. It began with a horde of unruly, uncivilized natives, and slowly, by kindness, education, and a system of rewards, has taught them law, order, and cleanliness. As soon as they were capable they were given an Assembly, with an Upper and Lower House, corresponding to our Senate and House of Representatives, in which they can make and pass their own laws. The Provinces, like our States, have each a governor, and gradually the control is turned over to the native government. All these matters are under the

A NATIVE OF BOSNIA, A TYPICAL CAUCASIAN

supervision of a Governor-General appointed by the President of the United States. If the Governor-General is unable at any time to preserve order, the army or navy kept in reserve comes to his aid. If an individual is to be punished he is sent to Bilibid Prison in Manila. This is really a school for the natives, where they are taught a trade. Public schools have also been established. The success of these methods has been the surprise of all nations. And it is still more to be wondered at when one considers that in the Philippine Islands one finds nearly every race of people on earth and almost every form of religion. As these islands are in a direct line of travel and a convenient stopping-place between East and West, travelers and traders of all nations have gone there and in time become a part of the make-up of the population.

The most important industry of the Filipinos is farming. The chief products are tobacco, hemp, cocoanuts, corn, rice, and sugar. As is the case with most Eastern peoples, rice is the chief article of food among the natives. The carabao, or water buffalo, is the chief farm animal, and the only pay he requires for his services is the privilege of going swimming from time to time or when his day's labor is over. These animals are especially fit for work in the wet rice fields.

The chief occupation of the women is weaving. They make cloth, hats, baskets, and mats. Though wages have considerably increased during the American occupation, they are still very low as compared with those paid in the United States. To all these people there is coming the change which contacts with the highly civilized outer world must bring.

PERSONAL CHARACTERISTICS

The Filipinos are short and slight, with small hands and feet, large eyes, flat nose, and full lips. They are brown in color, and in repose are very like a bronze statue.

The native Malays are divided into a large number of tribes, each speaking a different dialect. The Chinese are numerous, and Japanese, Arabs, Spaniards, other Europeans, and Americans may be found there, each speaking his own language. It is a very picturesque sight to see on the streets in Manila the different persons in their native costumes. The Americans mostly dress in white. The Chinaman wears the costume peculiar to his race. The Malay wears his shirt outside his trousers. The higher-class native woman wears a very bright-colored costume, invariably carrying a fan, while the peasant woman wears short skirts.

As the Filipinos become more educated and more used to carrying on a democratic government, they seek and gain from the United States a larger share in the management of their own affairs.

HIGH SCHOOL STUDENTS AT BACOLOD, PHILIPPINE ISLANDS

AMERICAN INDIANS

1, Aleutian; 2, Kolosche; 3–4, Eskimo; 5, Vancouver; 6, Crow; 7, Blackfoot; 8, Ojibwa; 9–10, Piute; 11, Shoshone; 12, Dakota; 13, Pawnee; 14, Mandan; 15, Apache; 16, Pueblo; 17, Mexican; 18, Orinoco; 19, West Brazilian; 20–33, South American.

THE INDIANS

LAST of all we come to our own red peoples, not new citizens, but Americans long before our ancestors knew that there was a continent across the seas.

When Columbus discovered America in 1492 he found living in the West Indies and Cuba, where he landed, a copper-colored race of savage people. Never dreaming that he had discovered a new continent, but believing firmly that he had reached India, he gave them the name of Indians, which has clung to the native red man of America ever since. Of late years, however, learned men have invented a new name for them, Amerinds.

Who and what were these strange people living in the wilds of America long before the white man ever set his foot upon its shores? It is believed that in very ancient times the ancestors of the Indians must have crossed over to America from the Eastern Hemisphere when both Europe and Asia were connected with America by land, now long vanished beneath the ocean. The Indians, it may be, were a blend of two races, Mongolic and Caucasic, but like no living race of men in Europe or Asia. Their habits and customs were peculiar to themselves. Our knowledge of the Indians begins with the year 1492. At that time not more than two hundred thousand of them lived east of the Mississippi, though they were doubtless far more numerous west and south.

THE WHITE MEN AND THE INDIANS

The Indians did not cultivate the ground. They lived by the chase. Up and down the great American wilderness they roved at their freedom, for they required ample space for their hunting grounds. Some of them, indeed, especially those living near the Atlantic coast, raised fields of corn and tobacco, and had gardens rich in melons, squashes, pumpkins, and beans. But on the very shores of the Atlantic they came into conflict with the white man. History tells us all about that exciting struggle, so hard and dangerous for the early settlers, so sad in the end for the poor Indian himself. We know that the weapons, the brains, the education, and the increasing numbers of the white men gradually conquered the untutored savage. More and more of his people were killed in battle, farther and farther westward he was driven, until to-day this is a white man's land. The numbers of pure-blood and mixed-blood Indians still surviving now live in the west and southwest on lands called "reservations," which our government has especially set aside for their use.

TRAITS OF THE INDIANS

The Indians have many striking characteristics. Their skin is copper-colored, from which they gained the nickname "redskins." They have coarse black hair, high cheekbones, and very commonly "Roman" noses. In the olden days, when going to war with other tribes, they painted themselves in lurid colors in order to present a fiercer aspect. They were very grave and dignified in manner, very silent, cautious, and reserved. They thought it beneath them to show feeling of any kind, and if captured by an enemy would let themselves be tortured to death without a quiver or a cry. Their power of endurance on the trail or the warpath was unbelievable. It was natural for the red man to be cruel and treacherous; nevertheless, he had a certain code of honor, and if he once entered into a treaty with the white men he religiously kept it.

The Indians lived in wigwams or tents made of skins, and their clothing was of skins. They made bone fish hooks with lines of hide or twisted bark, stone tomahawks, arrowheads and spears, wooden bows, arrows, and clubs. Two of their inventions proved of the greatest use to the early white settlers in their struggle with the wilderness. These were the birch-bark canoe and snowshoes. In the light and graceful birch-bark canoe one could travel for miles along the great American waterways, while the snowshoes enabled men to cover immense distances in the trackless forests in the dead of winter.

The Indian men devoted themselves to hunting and fighting, and their women folk did all the hard and useful work. They built the wigwams, made the clothing, and raised the corn and tobacco. Practically only one domestic animal was known among the Indians, the dog. A well-known historian has said that the Indians would not have been so backward

OLD POTTERY, MADE BY THE AMERICAN INDIANS

1 and 2 (center): from Mexico; 3 (large vase): from Argentina; the rest from Peru. One-quarter of natural size.

in civilization if they had possessed such useful animals as the horse, the ox, the cow, the camel, and the goat — animals which were known in Asia from the remotest ages. It is also interesting for us to know that our four great cereals, wheat, rye, oats, and rice, constituting all our main food supply, but corn, have come to us from Europe, as have many of our fruits. The Indians had none of these great aids to comfort and prosperity.

INDIAN TRIBES

The Indians of North America were divided into a number of great tribes or families. The Algonquins occupied all the east from Nova Scotia to North Carolina and stretched west to the Mississippi. At one time they numbered ninety thousand. The Iroquois or Five Nations had their seat in central and western New York. The Appalachians, embracing Cherokees, Creeks, Choctaws, Chickasaws, Seminoles, and a number of lesser tribes, occupied all the southeastern portion of what is now the United States. West of the Mississippi were the Dakotas or Sioux.

In New Mexico still dwell the descendants of a very interesting class of Indians called Pueblos, who do not live in wigwams or tents, but in large houses built of stone or adobe, several stories high, called pueblos. Each house shelters a large number of families. The Zuñi and Moqui tribes belong to the Pueblo group.

Another Indian tribe of note still living in New Mexico and Arizona are called the Navajos. They are a proud-spirited, self-reliant people, who rejoice in being untainted by white blood, and have won more or less renown from their skillful weaving of blankets. This industry, the handiwork entirely of their women, has rendered them a self-sustaining nation and freed the United States from the burden of supporting them. It is said that it is a very ancient industry. Long before the white men came to our continent the Indian women were weaving blankets. These blankets often sell

TEMPLES IN YUCATAN, PROBABLY OLDER THAN THE PYRAMIDS

Among the dense jungles of Yucatan have been found ruins of "Chichen Itza," "The Sacred City of the Serpents," built by races which lived on the North and South American continents in a time back of history. In the center of the city is the temple and castle, built on a pyramid of nine terraces, each faced with inlaid stone work. The body of a great stone serpent forms each of the four corners. Whoever these people were, they were master builders.

THE SERPENT MOUND IN OHIO

There are hundreds of mounds in Adams County, Ohio.

for large prices. The patterns are of great variety, many patterns representing a dozen or more prayers. Having woven her prayers into her blanket, the Navajo woman feels that the gods can in no way mistake the meaning. Few people realize the amount of labor required to make one of these blankets. The squaw measures on one finger the distance of an inch, and explains to her white neighbor that every strip of such width represents a day's work.

During the summer the Navajos dwell within a ring of brush or hut of green boughs. As cooler weather approaches, a framework of cedar logs is erected and covered with earth to the depth of several feet. A hole is made for the escape of smoke, and thus is completed the winter "hogan."

The Navajo doctors use no drugs. When a man is sick he is placed on a bed of blankets, while his Indian friends chant magic songs around him, in the firm belief that these will cure him. From the earliest times the Indians of every tribe have always believed in a Great Spirit and in a future life of happy hunting and feasting.

THE MOUND BUILDERS

LONG before the time of the Indians an earlier race of Americans lived in the Mississippi valley. We call them mound builders, because they have left some remains in the shape of great mounds of earth. These mounds must be very ancient, for the skeletons dug out of them often fly into dust as soon as exposed to the air, a rare occurrence with the oldest bones found in Europe. They are certainly very mysterious. Some were evidently built for military defense, others for burial places, others for religious uses. Many are in the shape of birds, fishes, quadrupeds, and men. In Adams County, Ohio, is a mound in the form of a gracefully curved serpent, one thousand feet long, with jaws agape as if to swallow an egg-shaped figure in front.

The mound builders made elegant pottery, worked bone and all sorts of stones, and even forged copper. Copper they mined in large quantities and carried down the Mississippi hundreds of miles from its source on Lake Superior. But they mysteriously disappeared from their northern homes, leaving their mounds behind them. Whether they were driven away by some terrible epidemic of disease or by some overpowering human foe we shall never know. It is believed, however, that they moved to the southwest and founded under better auspices a far higher civilization. They belong to the same family, so scientists tell us, as those wonderful ancient peoples of Mexico and Central America, the Aztecs, whose wealth and culture so astonished Cortez and the Spanish conquerors of Mexico.

The Aztecs of Mexico and the Incas of Peru, another great race of native Americans, teach us that the Indians of the southern parts of America arrived at a more advanced state of civilization than those of the northern parts, perhaps because of the tropical wealth of the country and the fact that gold and silver were so abundant. The wonderful temples of the Incas of Peru, their paintings and carvings, their gold and silver ornaments, their laws and government, filled the Spaniards with amazement, and to this day scholars are astonished at the traces they discover of the wealth and knowledge and art of that ancient race.

INDIAN WAR DANCE, AND A WARRIOR'S WEAPONS AND WARDROBE

These lower groupings of armor and weapons show the artistic skill and taste, and the elaborate embroidery and patient handiwork of the Indians.

A VILLAGE BUILT OVER THE WATER, NEW GUINEA, AND AN IGORROTE FARM IN LUZON, PHILIPPINES

ON THE ROAD FROM LONG AGO TO NOW

HOW PEOPLE LIVED IN PRIMITIVE TIMES, AND SOME OF THE ADVANCES THAT HAVE BEEN MADE IN LIVING

IT is a long road that we have traveled from the days of the earliest man to our modern civilization. The beginnings of the road are hidden in the dim, remote past, back of history or writing or record of any sort. Then, as the path winds along, it begins to emerge from this shadowy indistinctness, and there are signs and records scattered all along it. At first they are not very plain. The Indian hunter traveling a forest path was able to tell by the footprints on the soil and by the broken twigs of the bushes how many men and what kind of men had passed that way before. In the same way our students of to-day have been able, as we have seen, from the few footprints and traces which early man left behind, to picture for us his steps as he journeyed along the road of history, and to tell us what manner of man he was at each period. From his tools, buried in the dust of centuries or laid away in caves and cliff homes, we trace the stages of the road from the Metal Age back to the Iron Age, then to the Stone Age, and back of that to the age when there were no tools at all.

Now, before we leave the story of man as he has journeyed along this road from long ago to now, let us stop and retrace his progress by some of the interesting signs he has left behind. As we do it we shall see how many of our modern customs and possessions had their beginnings in primitive times. We shall learn better to appreciate our own luxuries and comforts and even the common things which we call necessities, but which our ancestors would have called luxuries of the most wonderful description.

THE FIRST HOMES

The earliest man had probably no settled home, but wandered about from place to place, seeking food and occupying such shelter as Nature afforded. But there is in men as in animals a strong home-building instinct. As the birds build their nests and animals have their lairs, so man came to want a home.

In the choice of shelter, he would be influenced by two ideas. He must be near a convenient food supply. If his life was that of a fisherman, he must settle along lakes or seas. If he was a hunter, born and bred in the midst of a forest, he would choose the spot where game was most plentiful. As he advanced in civilization and began to till the soil, or his women began to do it for him, he would select a smooth, well-watered plain or hillside. But before he came to placing his dwelling with reference to occupation or food supply, savage man would be in need of protection from his enemies and comfort for himself. He would take the home which with the smallest amount of effort on his part satisfied these conditions.

NATURE HOMES

Caves, cliffs, and nests in trees were the simplest homes, the former provided entirely by Mother Nature, the latter available with only a small amount of labor. The first tree dwellings were rude structures, not to be com-

LIKE A BIRD'S NEST: A PAPUAN TREE HOUSE

pared in skill with the finely woven, carefully planned nests of man's neighbors, the birds. To-day the tree nests of the gorilla and the orang-utan are woven of twigs and branches of trees with the floor piled high with dried leaves and grass. Captain Bradley, traveling in Burma, gives an interesting account of such shelters, which are probably very like those of the earliest men.

As his party was going along a river bank, their attention was attracted by what seemed to be enormous birds' nests in some of the trees. "The size of the nests was prodigious," writes Captain Bradley, "yet they were not placed at a very great height, nor in the tallest trees. We were puzzled to think what bird could construct nests of this size. . . . While we were still watching, a large ape left one of these nests and descended to the ground. He was soon followed by eight or nine others, who all walked about erect like men. The tree huts were from thirty to fifty feet from the ground; access to them was gained by a number of notches cut in the tree trunk. When we got amongst the branches we had to crawl out snake-fashion to get at the huts, which were the fashion of a beehive, though rather more pointed at the apex. They were constructed entirely of small branches and twigs tied together at the top and bent round to form the hollow space in the interior. The height of each hut was about six feet. . . . The entrance was a hole in the side so small that we could scarcely force our way in."

During the summer months or in warm countries these tree houses would be comfortable, but in winter they would be an insufficient protection from rain, wind, and cold. Then men, women, and children would be glad to creep into caves in rocks and cliffs.

DWELLERS IN HOUSES

The beginning of architecture was, then, the need of shelter. From the house in the tree it was an easy step to cut down a few branches and stick them in the ground for poles, binding together the upper ends and covering the whole with boughs or skins. Or perhaps the next step was to lay branches across between four trees to form a roof between the living uprights at the four corners. Here we have the first flat-roofed houses and the first tent-shaped shelters.

Among the various "queer peoples" of the earth we can see almost every style of primitive house. Tents are still the home of many wandering peoples. The first tents were probably of leaves or skins sewed together, stretched over a framework of poles. When men learned the arts of spinning and weaving, they made tents of wool, flax, and other coarse fibers. At last we have come to the tight waterproof canvas, which is the material of our army tents

to-day. But while these army and camping tents are serviceable, they are by no means the finest specimens of tent development. Alexander the Great, on his marches, occupied a tent so big that one hundred officers and servants could sleep in it. Its roof was upheld by eight pillars plated with gold. One Persian general of those days had a tent of redwood lined with embroidered purple satin, the roof supported by poles inlaid with mother-of-pearl.

HUTS

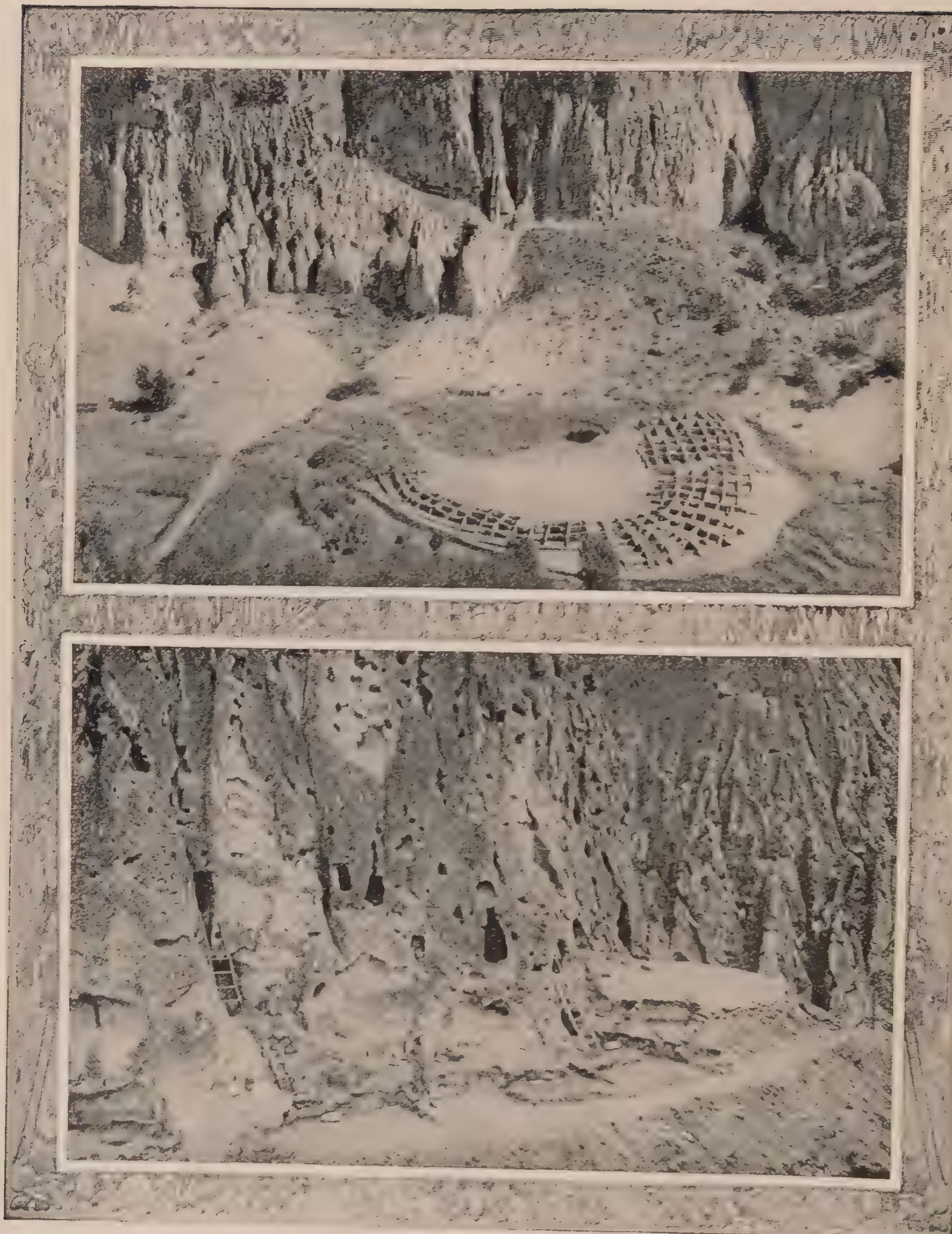
All these shelters were more or less temporary. The hut was man's first permanent self-built home. Thousands of people all over the world live in these simple dwellings built of straw, grass sod, brick, wood, stone, or whatever building material is most easily obtained. The beehive huts of the Hottentots are interesting structures covered with grass, thickly woven or plied. In the plains and lowlands of the world huts are made of clay and mud, dried into bricks or plastered over a framework of canes or bamboo poles. In our own country we find people in New Mexico and Texas living in huts made of adobe, which is an unburnt mud brick. In rocky regions homes will be of rock or stone. Our forefathers found timber on every side and built their cabins of logs. In Polar regions snow or blocks of ice are substituted for wood or stone.

LOCATION OF HOUSES

It takes almost as much wisdom to know where to put a house as to build it. The Swiss tuck their chalets away in sheltered nooks on the mountain sides; their warlike Teuton neighbors of the Middle Ages perched their castles on the highest spots they could find, and surrounded them with moats and battlements to make them secure against attack. Many southern peoples have built on piles driven in the water, finding that in these houses overhanging the rivers and lakes they are safer from attack of beast or human enemy.

Gradually the element of sociability enters in, and we have villages and towns and cities. Men no longer look out on a broad uninhabited space and decide the location entirely from

A SWISS CHALET, AND CASTLES PERCHED ON ROCKS



CLIFF DWELLINGS OF NEW MEXICO

In the cañon of Rito de los Frijoles, New Mexico, there have been found wonderful ruins of a forgotten race, that built extensive villages with great communal houses and ceremonial places. Some of the houses had over a thousand rooms each and were built with great solidity. In the upper picture are shown the entrance to an underground council chamber, and the ruins of a large communal house. Below are the cave dwellings of a great "Sun-house," dug out of the steep sides of the cañon and practically inaccessible to the enemy. Of the prehistoric people who built and dwelt in these homes no other trace remains.

the natural advantages. They gain protection from living in groups. Social relations develop, and we have our great modern cities. But no feature of house building which added to men's comfort has ever been lost. Architecture has changed, but it has kept every good thing which was to be found in the earliest frail structures of grass or wood or stone. We in our comfortable homes inherit the plans of many generations of builders, who set themselves each in his own surroundings to make the best homes they could.

HUNGER, A STERN TEACHER

Old Mother Nature was very wise in her plans for her human child. She knew that if he was to start out and conquer her forces and reach to the full height of his powers, he must have some incentive. If he was perfectly comfortable from the day he was born till the day he died, what reason would he have for exerting himself? But if he did not exert himself, what a lazy, undeveloped, uninteresting animal he would be! So Mother Nature put within him certain needs which should be his teachers.

Once in every three or four hours he was to be hungry, and if he did not satisfy this call by

SEMINOLES AT HOME

food he was to become more and more hungry until his need became so sharp as to drive him to almost any labor to get food lest he die. For back of all other instincts in man's nature is his hold on life. When his time comes, a man will be ready to die; but so long as he has any force to resist within him, he will make every effort to keep himself alive.

NATURE FOOD

The first food was what he could see about him — berries, fruits, herbs, and the roots of plants. Then came the hunting stage, in which the Pygmies and Negritoes have stayed. But savage man ate his meat raw. You have read

GRASS-ROOFED HOUSE OF THE TONGA ISLANDS

the myths of how he came to know how to cook it.

At first it seems very strange that, though knowing all about the ripening of the grain and the season of harvest, they did not take just that little step further and sow the seeds themselves. The Kwakiutl Indians, for instance, gather berries and roots, which are carefully dried for winter use. When required, the berries are first dissolved in water and then eaten in fish oil. They also dry sea grass for salt. But they do not cultivate the soil. The truth is that sowing of a seed was so radical and original a proceeding, so bold an hypothesis, and yet so perfectly simple, that the cleverest savage brains never thought about it.

Indeed, it was like the invention of fire, of the bow and arrow, and the first riding of a horse — it was a new departure. The first man or woman who intentionally planted a seed deserves a monument. The work of Shakespeare, of Napoleon, even of Euclid and the individual, whoever he was, who invented arithmetic, seems but a trivial and paltry affair when compared with that of this heaven-directed aboriginal.

THE MAIN STREET OF A FISHING VILLAGE, PORT MORESBY, BRITISH NEW GUINEA

Thatched roof shelters of the tropics.

One can see, in a way, how it came about. A Malay chief explained that the Besisi people used at one time to live on the fruits of the jungle. They at first ate the fruit in small shelters, which were set up near the spot where it was gathered. But it was noticed that many fruit trees sprang up near these shelters; so the tribe decided to carry the fruit to a little distance before eating it. Every year after this great discovery they took it to new places, and so enormously increased the number of fruit trees. Thus they deliberately distributed seeds of fruit trees through the jungle. They also cleared away the undergrowth around them.

Such an idea would of course catch on at once, or at least so soon as the people were sufficiently patient, honest, and amenable to advice. Probably the very first experiments, at any rate in tropical islands, would be with those wonderful plants, the sago palm, banana, cocoanut palm, and breadfruit.

AGRICULTURE

A very simple form of agriculture was practiced by the women of hunting tribes, who were left behind when their husbands were off on expeditions. Perhaps agriculture began in one of their experiments. As game grew scarce, or the attacks of stronger neighbors reduced the hunting grounds, it would become more important. Finally a wandering tribe would give up, first for periods of the year, and then for years at a time, their nomad life and begin to practice arts and industries, living meanwhile in more or less permanent homes.

Agriculture among these early peoples has been described as the most laborious but least precarious of human occupations. With some peoples it has advanced further than with others. Modern farming has become a science as well as a means of livelihood, and always the prosperity of a people, as in the case of our

own nation, depends on the proportion of its citizens who till the soil and make it bring forth, for they are the producers while the rest of the world are the consumers.

THE RISE OF THE ARTS

Has it ever occurred to you that of all the animals of the world man is the only one who has not an adequate covering but must provide for himself artificial clothing? The first men wore no clothes at all, or very simple clothes, leaves or skins sewed together or merely wrapped around the body. But as man advances he takes more pains with his clothing. In the making of garments for himself he travels a long way down the road of civilization and becomes possessed of many arts.

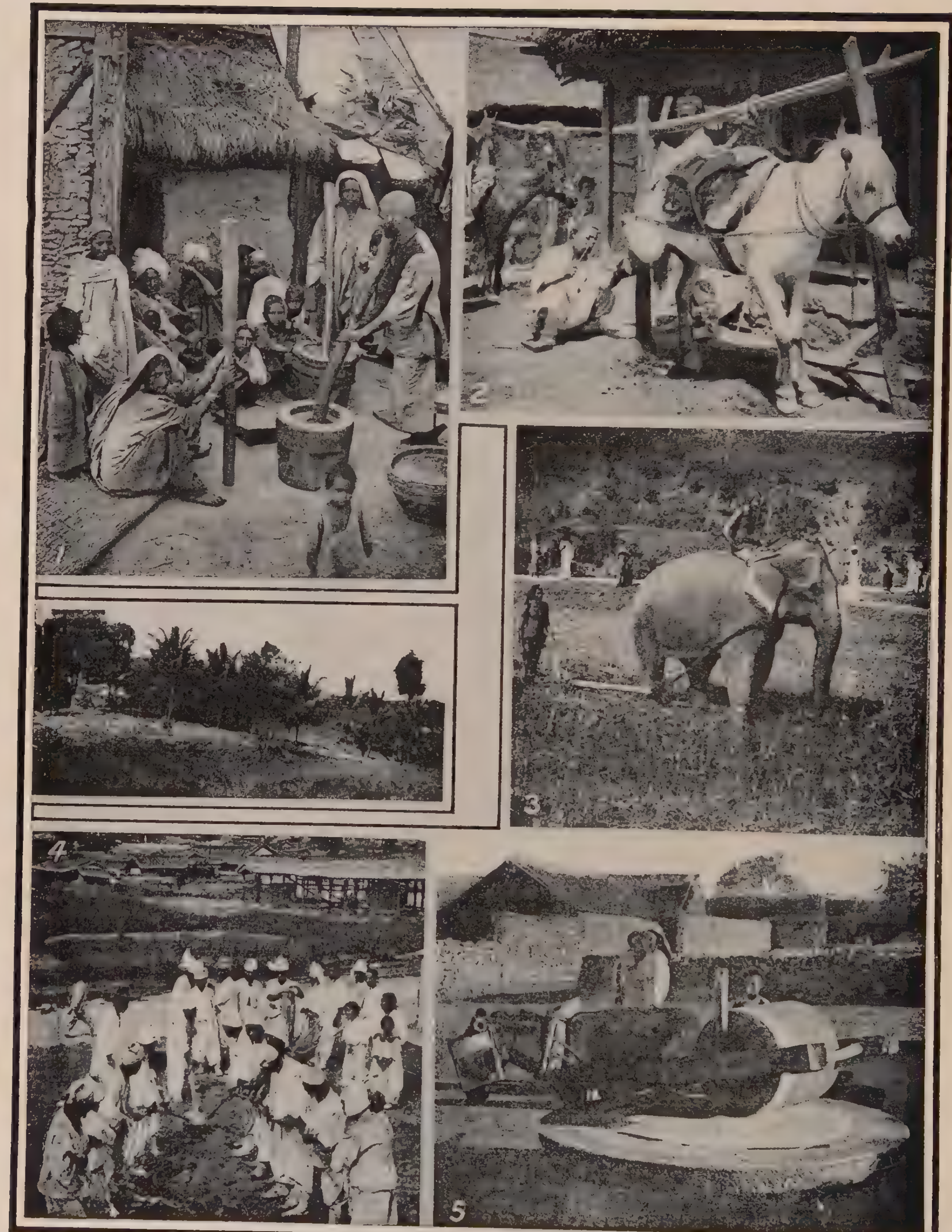
By the arts of a race are meant those processes which it has learned in order to supply itself with the articles which it desires. Man's wants were the cause of his inventions. The hunter wished to kill a bird or beast, and picked up a stone to hurl at it. Then he began to fashion a stone into a more useful shape, and we have the first weapons, made in the Stone Age. A sharp stone was a help in cutting, and next he sharpened a stone to a fine edge. Then he fitted it with a handle. The pictures show the rude implements and weapons of the Stone Age. The bow and arrow required more skill and ingenuity. The finest bows are those of the Pacific islanders, and Indians also made bows of great beauty. Next came the Copper or Iron Age with metal weapons, and lastly the age of firearms, dependent on the knowledge, so precious to man, and so important in his progress, of how to make fire.

Along with the art of weapon-making was that of fashioning utensils for use in peaceful occupations, preparing and cooking food, tilling the ground, carrying water, fashioning pottery dishes, and weaving baskets.

The Indian who made moccasins of his skins, and the Eskimo who shaped fur garments, had made great advances over the savage cavemen who tossed a skin across their shoulders and fastened it with a sharp prong. They had begun the art of sewing. The Eskimo and Alaskan tribes are remarkable for their exquisite sewing, in which they use animal sinew for thread.

But skins are not to be obtained in tropical

KAFFIR BEEHIVE HUTS



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PRIMITIVE WAYS IN MANY PARTS OF THE WORLD

1. Pounding corn in Cashmere, by lifting a heavy pole and letting it fall on the grain. 2. Shoeing a pony in Korea. 3. An elephant plowing. 4. Digging the foundations of a house at Seoul. 5. A pony mill in Manchuria, grinding maize.

countries. There it was the bark of trees and grasses which must be shaped, and plaiting was invented. Spinning wool into threads and weaving it into cloth was a great step, but it was taken by many primitive peoples, who wove not only their clothes but their tents, as the Arabs and Bedouins have done for centuries. The Chinese say that it was the wife of one of their emperors, who lived more than thirty-five centuries ago, who first found out how to make silk. The weaving of cotton was probably discovered much later.

Along with clothing came the need of other articles. The first pins were thorns, and the first needles, like those of Eskimo women to-day, were fishbones, or, in tropical countries, perhaps bits of wood. The love of ornament developed many arts, from the stringing of beads to the cutting of gems and working of metal into necklaces and ear and nose rings.

WHEN DO MANUFACTURE AND TRADE BEGIN?

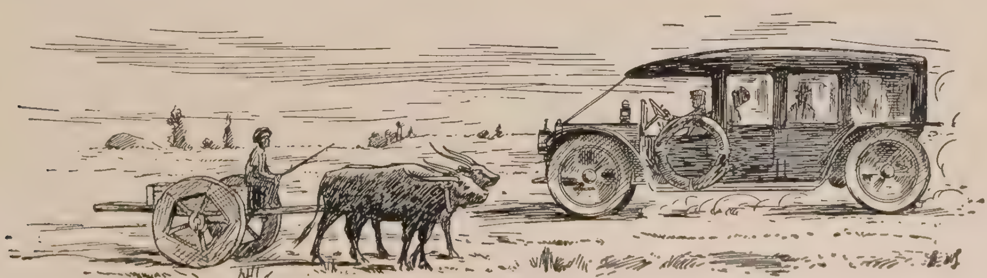
When articles are made for exchange instead of only for personal use, arts are passing into manufactures. This social interchange begins so early that it is impossible to draw the lines. When one particular kind of work is always done by one set of people, division of labor has been established. This is the first step towards manufacture. One group of people learns to do a thing well, and others take advantage of their skill. This is practiced among even backward peoples, and becomes an elaborate system in a civilized nation. Manufactures come through the discovery of the arts; they grow with the progress of society, until we have great manufacturing communities.

Trade begins with the desire of men to exchange something which they have and do not need, for something which they do not have but desire. The first dealings of white men with savages is the bartering of certain articles, and savages practice the same interchange among themselves. Almost every people has something which its neighbors have not. At first trade was very limited, geographically. No one knew of the possessions of any but their nearest neighbors. But with the improvement of means of transportation the field of exchange broadened until it covered continents and oceans, and in our own day encircles the whole world, and binds the human family together in ties so strong that they cannot be broken without injury to all parties.

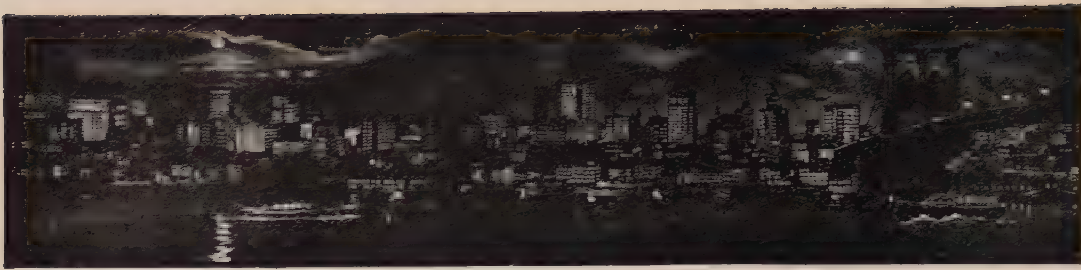
THE BLESSINGS OF CIVILIZATION

The road which man has traveled since his first appearance on the earth has been long and often hard, but the journey has been very much worth while. He has increased his comfort and power, and his mind has developed with every step along the way. By working out the instincts and wishes which were born in him he has broadened and deepened his mental and spiritual powers. To-day he stands, as never before, master of the earth, enjoying the luxuries which his invention and industry have brought him, and able to make his work count for more towards human progress and betterment. No race travels the road alone. What one has learned, another will be taught, until the whole human family become sharers in the heritage of the ages.

"What a piece of work," says Shakespeare's Hamlet, "is man! how noble in reason! how infinite in faculties! in form and moving how express and admirable! in action how like an angel! in apprehension how like a god! the beauty of the world! the paragon of animals!"



ON THE ROAD — THE PRIMITIVE AND THE MODERN WAY



THE GREAT CITIES IN PICTURE

THE FAMOUS CAPITALS OF THE LEADING COUNTRIES OF THE WORLD

IN the great cities man has reached the highest point of development in the art of living. This has been true from the earliest recorded history, and among all people that have established anything like national life. Into the building of cities human genius has poured itself; in the city environment art and science have flourished; the community needs have called forth the inventions and improvements, the elegancies and luxuries, as well as the sanitation and conveniences which mark the constant advance of civilization. While the country has ever been the underlying source of wealth, and of sturdy character and physique, the city has been the scene of the greatest achievements, the center of commerce and manufacture, the storehouse and banking house, the hive of human activities. It is impossible

MADISON SQUARE, NEW YORK

The Metropolitan Building, with the second highest tower in the world, forty stories. Broadway and Fifth Avenue cross on the left.

to escape the attractions of the city. Many may prefer to live in the country, but all desire to see and enjoy something of the varied resources, advantages, and amusements of the city. We purpose to give glimpses of some of the chief cities of different lands, in a brief Picture Tour.

It is interesting and surprising to note, as we study the census figures of the world, that of the twenty-three cities which had by recent reports a population of a million or more inhabitants, China had three, the United States three, India two, Japan two, Germany two, Russia two, while Argentina, Austria, Brazil, England, France, Hungary, Mexico, Scotland, and Turkey had one each.

We begin with New York, not only because it is the metropolis of our country, but because it has become the first port of the world in commerce, and shares with London in financial leadership.

THE LARGEST CITIES OF THE WORLD

Cities	*Population*	*Cities*	*Population*
London	7,476,168	Calcutta	1,327,547
New York	5,620,048	Osaka	1,253,000
Tokio*	5,164,000	Peking	1,200,000
Berlin	3,804,000	Constantinople	1,200,000
Paris	2,907,000	Budapest	1,184,616
Chicago	2,701,705	Bombay	1,176,000
Vienna	1,850,000	Rio de Janeiro	1,157,873
Philadelphia	1,823,779	Mexico City	1,080,000
Buenos Ayres	1,721,500	Petrograd	1,067,328
Moscow	1,542,874	Glasgow	1,034,000
Shanghai	1,539,000	Hamburg	1,025,502
Hankow	1,500,000		

THE FIFTEEN LARGEST AMERICAN CITIES

Cities	*Population*	*Cities*	*Population*
New York	5,620,048	Pittsburgh	588,343
Chicago	2,701,705	Los Angeles	576,673
Philadelphia	1,823,779	Buffalo	506,775
Detroit	993,678	San Francisco	506,676
Cleveland	796,841	Milwaukee	457,147
St. Louis	772,897	Washington	437,571
Boston	748,060	Newark	414,524
Baltimore	733,826		

*Before the earthquakes of 1923–1924.

THE BUSY HARBOR OF NEW YORK, LOOKING FROM THE BATTERY, WITH THE STATUE OF LIBERTY IN THE DISTANCE

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SINGER BUILDING AND CITY INVESTING BUILDING, NEW YORK, AT NIGHT

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NEW YORK, THE MOST WONDERFUL OF CITIES FOR SKYSCRAPERS

The upper view is of the City Hall, with background of high buildings. The lower shows the skyscrapers on lower Broadway, with West Street and the steamship piers on the left. The Singer Tower and Woolworth Tower are on the right.

THREE FAMOUS LONDON VIEWS

Above: Houses of Parliament on the Thames, with St. George's Clock Tower at right.
Middle: Trafalgar Square, with Nelson Monument, National Picture Gallery on right.
Bottom: Tower of London, from the River, its White Tower dating back to 1070. Here state prisoners were confined and executed, for treason and other high crimes.

VIEWS IN LONDON, THE LARGEST CENTER OF LIFE IN THE WORLD

1. The Victoria Embankment on the Thames. 2. Tower Bridge. 3. Wellington Monument, Liverpool. 4. Rotten Row, famous promenade and driveway of Hyde Park. 5. Westminster Abbey. 6. Tower of London. 7. Piccadilly Circus, the "hub" of traffic, center of clubs and theaters. 8. Bank of England on right; Mansion House on left. Bank (founded 1694), occupies four acres; has no windows on street, getting light from courts; keeps at least twenty million pounds of gold and silver ($100,000,000) in the vaults. Strongest bank in the world. Mansion House, official residence of the Lord Mayor; built 1739–1753, with fine Corinthian portico, from which official proclamations are made.

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PARIS, THE FRENCH CITY BEAUTIFUL

The panorama at the top shows the Eiffel Tower. Below (left): a bird's-eye view of the city showing the river Seine with its many bridges; (right) a view from Notre Dame with its gargoyle heads in the foreground and a nearer look at the Seine.

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PARIS AT WORK AND PLAY

Above (left): an afternoon scene on the Boulevard, throngs passing Porte St. Denis; (right) the Arch of Triumph, and approaching Boulevard. Below: the Flower Market by the Seine.

BERLIN, GERMANY'S GREAT CAPITAL

Top row (from left to right): French Cathedral, Arcade, Statue of Frederick William III. Second row: Unter Den Linden, the great boulevard of Berlin, and the Column of Victory. Third row: Royal Palace, Monument of the Great Kurfurst. Bottom row: Schiller Monument and Royal Theater, Bourse.

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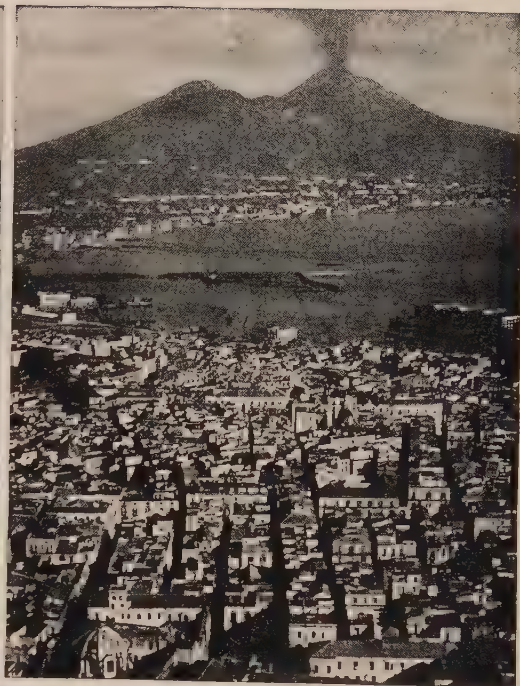
A GLIMPSE OF GERMANY, BELGIUM, AND HOLLAND

Top (left): the Palace of Justice, Brussels, Belgium; (right): Dresden and the great western head of the Elbe.
Bottom (left): Amsterdam, its streets and canals; (right): quaint old Heidelberg on the Neckar River.



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ITALIAN VIEWS

Above (left): Florence, with the Cathedral at the right and Palazzo Vecchio in the center background; from its bell-tower watchmen used in the olden days to give warning of approaching enemies. To the right is the Bay of Naples, with Vesuvius. Below: Rome from the dome of St. Peter's.

CASTLE AND BRIDGE OF SANT' ANGELO, ROME (above); MONACO AND MONTE CARLO (below)

TWO BEAUTIFUL CITIES OF ITALY

Above: Florence, the home of the Brownings and George Eliot, the scene of "Romola," and the city of Savonarola. Below: the water front of Genoa, the chief seaport of Italy and noted as the birthplace of Columbus.

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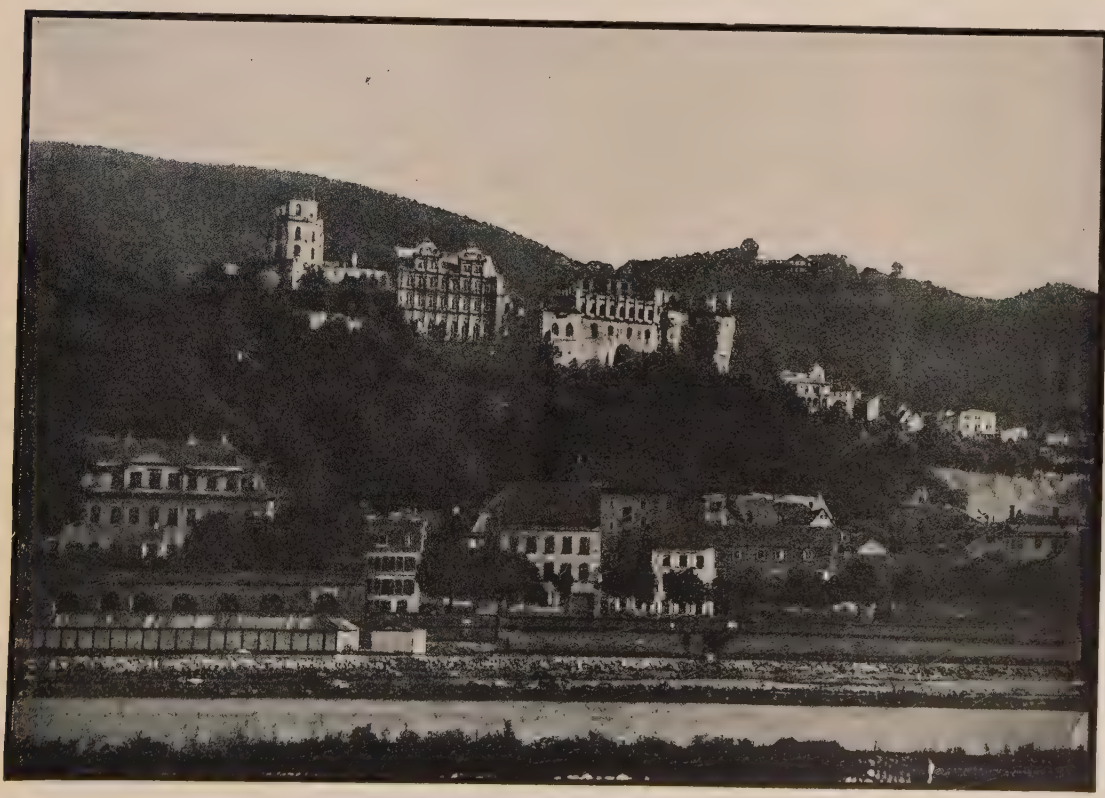
SCENES IN SPAIN

The upper view shows wayfarers approaching Salamanca, whose bridge and cathedral stand out in the background. Below to the left is a square of Madrid; to the right, the center of old Seville.

MARSEILLES AND SAN REMO

The upper picture is of Marseilles, the chief city and port of southern France; the lower of San Remo, a beautiful winter resort on the Gulf of Genoa, Italy.

GENEVA, SWITZERLAND, WITH MONT BLANC IN THE DISTANCE



HEIDELBERG CASTLE, FROM THE RIVER

VENICE, THE MISTRESS OF THE SEA

The Rialto; Gondolier on the Grand Canal; the Bridge of Sighs; St. Mark's; the Ducal Palace; a Venetian Street; San Giorgio Island; on the Piazzetta; the Grand Canal and Rialto.

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A REMARKABLE GROUP OF WORLD CITIES

Top: Bombay, India; Cologne, with Cathedral in distance; San Juan, chief city of Porto Rico. Middle: Public buildings in Mexico City; Union Square, San Francisco. Bottom: The Imperial City, Peking; a Boulevard of Vienna; the famous Cathedral of Burgos, Spain. Thus we have glimpses in India, Germany, Porto Rico, Mexico, United States, China, Austria, and Spain, with beauty in all.

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ATHENS OLD AND NEW

A view from Mount Lykabettos, with the Royal Palace of to-day at the left, and the wonderful Acropolis with its group of temples in the center.

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CONSTANTINOPLE, CROWDED CITY OF THE MOSLEM TURKS

Above: Bird's-eye view of the Marvelous City. Below, at the left: Galata Bridge connecting Europe and Asia; at right: Constantinople seen from the tallest tower in Stamboul.

PETROGRAD, RUSSIA

Top: Palace Bridge, Admiralty Building and St. Isaac's Church. Bottom: Admiralty Building and University.

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RUSSIAN AND FINLAND SCENES

Top: "The Fair," at Nijni-Novgorod, Russia, and Queen Catherine's Statue. Bottom: Market Place, Viborg, and market boats, Helsingfors, Finland.

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THE PODOL, OR MERCHANT QUARTER OF ANCIENT KIEFF, OR KIEV, RUSSIA

Chief town of Kieff, Government of Southwest Russia; on Dnieper River, 660 miles south of St. Petersburg. From 200,000 to 350,000 Pilgrims visit this religious center annually.

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CAIRO, CAPITAL OF EGYPT, ON THE EAST BANK OF THE NILE

There are at least 150 mosques in Cairo, and graceful minarets are everywhere to be seen. Here are the palaces, public buildings, barracks, museums, and opera house. There are practically two towns, the European and the native. The population is about three-quarters of a million.

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PANORAMIC VIEWS OF MEXICO

At the top: Puebla City, Cathedral on left, Mt. Popocatepetl in the distance. Bottom: Mexico City, the capital, from the President's Palace. In the streets of this beautiful city revolutionary battles are frequently fought. The distant mountain range is the source of invigorating coolness and beauty.

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TOP: RIO DE JANEIRO HARBOR. BOTTOM, LEFT: AVENIDA CENTRALE, RIO DE JANEIRO; RIGHT: COLUMBUS STATUE, CARACAS, VENEZUELA

Courtesy of Canadian Pacific Ry.

ST. JAMES STREET: A LEADING BUSINESS THOROUGHFARE OF MONTREAL, CANADA

THE BOSTON OF HISTORY AND EARLY COLONIAL DAYS

THE BOSTON OF TO-DAY, THE CHIEF CITY AND PORT OF NEW ENGLAND

HISTORIC PHILADELPHIA

Above: Betsy Ross House; Liberty Bell. Below: Independence Hall.

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MODERN PHILADELPHIA

Left: (above) The Washington Monument; (below) Broad Street looking north toward City Hall. Right: Market Street; Broad Street, looking north from City Hall; Dock Street.

BALTIMORE, THE METROPOLIS OF MARYLAND

Left: (above) the Washington Monument; (below) the tower building. Right: the City Hall; the Post Office and a skyscraper office building; a bird's-eye view.

MICHIGAN BOULEVARD, ON CHICAGO'S LAKE FRONT, HOTEL BLACKSTONE IN FOREGROUND

THIS LAKE FRONT BOULEVARD IS ONE OF THE GREAT AVENUES OF THE WORLD

DREXEL BOULEVARD, A PART OF THE GREAT PARK AND BOULEVARD SYSTEM OF CHICAGO

THE LAKE FRONT, CHICAGO, WITH ITS SKYSCRAPERS, FORMS AN IMPRESSIVE SKY LINE

A VIEW ON STATE STREET, THE CHIEF RETAIL BUSINESS STREET OF CHICAGO

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TACOMA HARBOR

Capitol Copyright, Harris & Ewing

OFFICIAL WASHINGTON

Top: The Capitol. Middle: State, War, and Navy Departments; United States Treasury. Bottom: Library of Congress, with its Hall of Columns.

White House Copyright, Harris & Ewing

WASHINGTON VIEWS

Top: The White House. Middle: Municipal Building; Patent Office. Bottom: Panoramic view, from the State Department; New National Museum.


F.R.HARPER